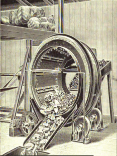

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THE ELECTRICAL ENGINEER.

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NOTES.

Kidderminster.—The Bill confirming the Kidderminster electric lighting has been passed.

Carbon Trusts.—It is stated that a "trust" is being formed of the principal American electric carbon manufacturers.

Dover.—We may remind electrical engineers that the tenders for Dover electric lighting are to be sent in on the 10th inst.

Whitby.—The Bill for confirming the provisional order for Whitby has been ordered for second reading in the House of Lords.

Steam Separators.—Prof. Carpenter, of Sibley College, Cornell University, has recently carried out a series of experiments on the efficiency of steam separators.

Sales.—Our readers will notice the continued advertisement of sales of plant at the Albert-embankment and Quintin Matsy's Forge, to which we have already called attention.

French Cables.—The *Times* correspondent states that in the French Senate on Wednesday a grant of 5½ millions for cables between Marseilles and Tunis and Marseilles and Oran was agreed to.

Cardiff.—Messrs. Gilbert and Co., Hanway-street, W., have secured the contract for a complete installation at Messrs. Hopkins, Market, Cardiff, with a large number of arc and incandescent lamps.

Edinburgh Exhibition.—A second dividend, making 16s. in the pound, has been paid by the liquidator of the Edinburgh Exhibition. The materials are being sold, and a further dividend will be declared.

Telegraph in Scotland.—The Post Office extensions of the telegraph go on from time to time, reaching further and further into remote districts. One of the latest of these is to Pitlochry and Loch Tummel.

Bridge Lighting in London.—The Bridges Committee of the London County Council find there is not sufficient light on the bridges crossing the River Thames, and extra burners are to be added at the cost of £100.

Winslow (Bucks.).—The electric light was tried at Winslow on Friday evening last, when it proved a great success. Gas directors will have to take less for their gas, or, it is thought, it will not be required for the coming winter.

Swiss Electric Launch. — The Oerlikon Works, together with MM. Escher-Wyss, have built an electric boat, which has recently been launched on "Zurich's bright waters." The boat is capable of running six hours continuously, at eight miles an hour.

Spanish Cables.—Submarine cables have been laid successfully between Tarifa and Tangiers, and between Tunara, a fishing village situated eastward of the Spanish lines, and Cueta, the Spanish settlement on the Moorish side of the Striats of Gibraltar.

Selby.—Contracts are required for the lighting of the public lamps of the town, by the Selby Local Board. The prices are to be per lamp, from August 1, 1891 to May 31, 1892. Tenders to be sent in by July 3 to Mr. J. H. Bantoft, clerk, Finkle-street, Selby.

Street Lighting in France.—In reference to the paragraph under this heading last week, we are informed that the installation carried out by M. Clemançon, of Paris, is on the Bernstein system, the lamps having been supplied by the Bernstein Electric Lamp Company.

Accrington.—The Markets Committee of the Accrington Corporation have recommended the Town Council to introduce the electric light at the Town Hall, and also to consider the powers granted to the Corporation for a further extension of electric lighting within the borough.

Telephone Patents.—Our readers will notice that the National Telephone Company are calling attention to the fact that all their patents do not all expire this month, and that proceedings will be taken against persons making transmitters upon the patents which do not expire till 1892 or 1893.

Birmingham.—Mr. Charles A. Smith, of the Athenæum, 71, Temple-row, Birmingham, has been appointed agent to Messrs. Woodhouse and Rawson for Birmingham and district, and has opened showrooms at the address given, where samples of goods may be seen, as well as local orders executed from stock.

Storage Cars.—A successful electric storage car system is reported in operation in Dubuque, Iowa. After years of investigation, Mr. Rhomberg, the president of the line, has instituted this system. The cars run at 10 miles an hour, and swifter cars are to be put into operation. The Accumulator Company's batteries are used.

Cricket.—A friendly game was played on Saturday at The Elms, Acton, in a field adjoining the works of Mr. Ronald Scott, between an eleven got up by Mr. Scholey, of the *Electrical Review*, and an eleven from the works of Mr. Ronald Scott. A very enjoyable afternoon was spent, and we are informed that the return match will be played on the 25th inst.

Duke of Hamilton's Telephone.—The telephone which connects Brodick Castle and the Duke of Hamilton's shooting lodge at Doughie with the chamberlain's house and postmaster's house at Brodick was satisfactorily completed on Saturday. The work has been executed by Messrs. Cox, Walker, and Co., electrical engineers, Edinburgh and Darlington.

Queen Anne's Mansions.—A separate company has been formed to light the Queen Anne-mansions. It has been pointed out that the London Electric and the Westminster are the only companies who have applied or are applying for parliamentary powers in this district, and that operations of the above company will be confined to the Queen Anne's-mansions.

West Cowes.—The Local Board of West Cowes, Isle of Wight, require tenders for 160 public lamps of 20 c.p., to be fitted on the present gas lamps. The tenders are asked for oil lamps, but it is probable information on electric lighting would be received. The tenders are required to be sent in to Mr. H. J. Dament, clerk, High-street, Cowes, by July 4th.

London Lighting Company.—The Commissioners of Sewers have withdrawn their threatened opposition to the provisional order granted by the Board of Trade to the Brush Electrical Engineering Company for the electric lighting of a portion of the City of London. This order, which has already been confirmed by the House of Commons, will now pass without any further opposition through the House of Lords, no other petition having been presented against it.

Westinghouse Engine Governor.—The Westinghouse Company, after two years of experiment, are announced as having brought out a governor for high duty compound engines, whose efficiency has never been equalled. It is a combination of cranks, two springs, and heavy unbalanced eccentrics. A severe test, in which 250 h.p. was thrown off in three seconds, showed the engine to be perfectly stable on running with this governor.

Marriage.—We have to offer our sincerest congratulations to Mr. Albion T. Snell, engineer to the General Electric Traction and Power Company, on the occasion of his marriage, which took place on Monday. The employés and staff of the "Immisch" Works, at Kentish Town, presented Mr. Snell with a handsome timepiece and card-table as a mark of their respect on the occasion. Mr. and Mrs. Snell leave for a tour in Devonshire and Scotland.

German Exhibition.—This exhibition is becoming more and more successful as the season progresses. What with German exhibits, pictures, panoramas, and the magnificent dramatic representation of "Germania," to say nothing of illuminations and the splendid bands, the gardens at Earl's Court form a centre of attraction always thronged with visitors. There are some new types of oil engines and some fine electric lustres to inspect for those who require business attraction as well as pleasure.

Carshalton.—Tenders are invited by the Carshalton Local Board for the lighting of their district (consisting of the entire area of the parish of Carshalton) with gas, oil, or other illuminant at per lamp, exclusive of the costs of columns, frames, and lanterns, for 12 months from 31st July. Tenders, marked "Public Lighting," and addressed to the chairman of the Board, must be deposited at the Board offices at or before 12 noon on 8th July. Particulars from Mr. James W. Manley, clerk, High street, Carshalton.

Protection against Hail.—It appears that the country round Tarbes in France is subject to frequent and often very severe hailstorms, and, being a seat of the *petite culture*, many valuable crops and glasshouses are destroyed. The director of the observatory of the Pic du Midi, M. Vaussenat, has arranged a series of poles furnished with metallic tips, and connected by wires on the crests of the hills around, with the view of reducing the electrical tension of the clouds, and thus obviating the destructive hailstorms.

Helston (Cornwall).—A meeting of the Helston Town Council was called last week to consider the lighting of the town. Mr. Cade moved that Mr. Veale, of St. Austell, be asked to give an estimate for lighting the town with electricity. He thought they should try some other means rather than cramp themselves with the Helston Gas Company. Mr. Dale seconded this, for, although he could not hold out much hope that they would be illuminated with the electric light, it would be well to know the cost. The resolution was carried.

Storage Traction.—An article in the *Street Railway Gazette* on storage battery traction ends with the following sentence: "One reason for the apparent failure of the storage battery to come up to the exacting requirements of street railway service has been the attempt to do too much with too few cells, exactly as if the attempt were made to run a road with too few horses. Say, for instance, if five sets of cells were provided for two cars instead of four sets, as at present, ample time would be given to fully charge the cells, the wear and tear greatly reduced, and the service greatly improved."

Tramways Institute.—The annual meeting of the Tramways Institute, which was held yesterday under the presidency of Mr. Carruthers Wain, was well attended. Considerable discussion occurred on Mr. Kapp's paper describing the Lineff system, which is now arranged so that the insulation resistance of line is greatly increased. Messrs. Reckenzaun, Sturgeon, Dickenson, and others participated in a lively discussion. Mr. Jarman read a paper describing his system, and exhibited a model of his car. The general tone of the meeting was favourable to electrical traction, the main question being, will it pay?

Telephone Facilities in Scotland.—The Telephone Company are endeavouring to remedy the defective telephone service which has arisen between the Border towns and Edinburgh since the interposition of an exchange at Penicuik, by laying a new line between Penicuik and Edinburgh for local service only. The existing line between Edinburgh and the Border districts is to be reserved for the exclusive use of the southern towns. A new line is also to be laid *via* Peebles to connect Galashiels and the other Border centres directly with Glasgow and the West of Scotland The Kelso and Jedburgh lines will shortly be ready for use.

Zinc Elements.—Messrs. Moseley and Sons, of Manchester, are introducing a form of zinc elements for batteries, says the *Manchester Examiner*, built up by sliding tubes of thin, almost pure, zinc into one another. Each tube is amalgamated before the element is put together, and the mercury permeates the whole wall of the tube, as the latter is only $\frac{1}{32}$in. thick. The amalgamation is accordingly very perfect, and local action is entirely got rid of. The manufacturers state that when these elements are used, no time has to be spent in cleaning and scraping the zincs, which remain free from chloride of zinc and crystals till completely expended.

Telephones in Stockholm.—The Telephone Company of Stockholm have considerably reduced their charges and introduced a novel feature into their service. The charges have hitherto been £5 to £7 a year. This is now reduced to an all-round charge of 12s. only, for which instruments and wires are installed. Needless to say, for this sum everybody who has the slightest use for the telephone can have it. Besides this charge the subscribers pay 1½d. per conversation, the apparatus being supplied with a counter. Only those who use the telephone very often would have to pay rates at all high, and for these, special inclusive fees can be arranged.

The Electric Light on Snowdon.—"Sir Edward Watkin," says a Welsh correspondent of a Manchester paper, "is going to do great things on Snowdon. He is having the electric light fixed at the summit of the mountain. The light is to be so powerful as to light up every crag and precipice of the great mountain even in misty weather. Moonlight ascents of Snowdon in summer are very popular, but one would expect that they would be as nothing compared to what ascents by electric light will be if Sir Edward is able to work out his scheme. The experiment will be so novel that as soon as the news goes out that the light is on, Llanberis may count on a large influx of curious tourists."

Electric Railways.—"The longest electric railway in the world," says the *Financial News*, "is to be built between Asheville and Rutherfordton, in North Carolina. It will be 41 miles in length, and both passengers and goods will be carried. The necessary power will be obtained from a fall of water, and, when completed, the line will be the only electric railway constructed to deal with both freight and passenger cars." The line may be the longest electric railway yet built, but it is certainly an error to imagine that it will be the only electric line to deal with goods as well as passengers. The Bessbrook line, among others, constantly takes large quantities of goods traffic. It is, however, a good sign that lines of this length are being built as really electric "railways."

Babcock and Wilcox.—We notice that the prospectus is issued of Babcock and Wilcox, Limited. The share capital is stated at £240,000, of which £100,000 is to be in £10 six per cent. cumulative preference shares, and the balance in £10 ordinary shares. The vendor is to take one-third of each class of share in part payment of the purchase-money of the European patents and businesses of Babcock and Wilcox, water tube steam boiler makers. All the balance of the shares is offered to the public. It is not to be denied that the Babcock and Wilcox boilers have hitherto achieved considerable success in Europe, but £240,000 is an immense sum for the public to pay for practically "patent rights" in the boiler business, and the point is, when these patent rights run out the boiler will be open to everyone to make. We are not altogether inclined to the opinion that these boilers are the best suited to electric light purposes.

Weymersch Battery.—We have received a prospectus from the Weymersch Battery Syndicate, of Victoria-mansions, who announce that they have taken works at Colwell-road, Dulwich, for manufacture. Although the battery has been before the public some time, the directors have refrained from bringing it forward until it had repeatedly stood the test of practical work. They now announce themselves justified in recommending the battery for producing electric energy for light and motors on some scale. A battery is shown at the offices driving a Blackman's ventilating fan, and it is stated that a similar one is being used for an electric launch. A complete installation is also shown fitted up for electric light. The syndicate do not claim that the battery can compete with a large electric central station, but that it can be successfully and economically used in private houses for light and power. The mode of charging the solution is easily managed by means of simple taps.

Electric Lighting of Paris.—The *Daily News*, always the most open of our great dailies to affairs electrical, has the following note in its editorial news column: "Paris, according to Mr. Albert Shaw, is now the best lighted city in the world, and a model for all cities that are bent on introducing electric lighting on a grand scale. It is the great installation under the vast central markets of Paris that has enabled the municipality to command the situation and to carry out a scheme which has been settled, not hastily, but after a patient, scientific, and systematic study. This installation, however, has never been intended for the general work of lighting; it is for experimental purposes, and also for acting as a regulator of charges, each division of the city radiating from this centre being leased for a limited term to a responsible electric company. The old troublesome question of how to dispose of wires never arises in Paris, where, thanks mainly to the subways, there are absolutely no obstructive wires."

Visit to the Frankfort Exhibition.—At the recent meeting of the Electrical Section of the London Chamber of Commerce, one of the subjects discussed was the formation of a party to visit the Frankfort Exhibition. It was generally felt that there were greater privileges and facilities afforded in the way of guides, etc., when the visit took the form of a representative party than there would be in the case of a visit as private individuals. The authorities of the exhibition have been communicated with, and have expressed themselves favourably towards the proposed visit, which would probably extend from the 5th to the 15th September. With the view of determining whether the visit can be made in the form of a party, the secretary would be pleased to hear from electrical engineers as to whether they propose to visit this exhibition or not, and if so, whether they would wish to become one of the party, and if the date named (September 5 to 15) would be suitable.

Tramcar Tickets.—The New York *Electrical Engineer* records an admirable departure in the way of bus and tram tickets. It says the Belt Electric Line Company has abandoned the use of bell punches on its cars. Receipts are given by the conductors for cash fares. These receipts are put up in pads, 100 to the pad. Each pad has its distinctive number, and each receipt its serial number. The conductors are charged with their money receipts every night, and when they settle the next night must return the receipts in the pad, or must return cash to correspond with the missing receipts. In order that the public may be interested in receiving and taking care of these receipts they are given a money value—that is, upon the return of 100 receipts at the office of the company the bearer will be entitled to six street car tickets. In other words, the receipts are worth 1s. a hundred. This is certainly enough to justify people in saving them, and many small boys and girls will doubtless take an interest from this time on in collecting the receipts.

Simple Ammeter.—A really good, entirely satisfactory, and simple direct-reading ammeter seems yet to be invented. We have seen a simple enough one at the Acme Electric Works, the invention of Mr. Adrian D. Jones, of their testing department, late student of the City Guilds College. The "Acme" ammeter, as it is to be called, depends upon the uncoiling of a spring to compensate the varied motion of an armature in a coil. The long pointer is attached to a pivot, which is actuated by the moving armature through a long spring coiled once round the pivot before being attached. The consequence is that at the point where the greatest movement of the armature is met with, most of its motion is taken up by the spring, and comparatively little movement is given to the needle. On the other hand, in the position when little movement is given to the armature by a certain strength of current, the spring being uncoiled, the movement acts to the full extent. The scale is a long and open one, 8in. or 10in. diameter for 50 amperes, giving great space for readings. Each spring is fully tested before making up, and the instruments are carefully calibrated direct in amperes.

Testimony from Bath.—The *Bath Herald* says: "We have now had just over a twelvemonths' experience of electric lighting in our thoroughfares—the streets having been lighted for the first time on Midsummer night last year—and though there are still a few croakers, who endeavour to pick holes and find fault with it, I question whether there are many, if any, who would like to go back to the system of lighting by gas—save and except, of course, those who from interested motives refuse to break their allegiance to the old system. Difficulties which were at first met with now appear to have been entirely overcome, and the light burns as steadily and evenly as any installation I have seen. It has already been the means of bringing the city into considerable notoriety, as evidenced by the number of deputations which have from time to time visited us from other places where the adoption of the light is under consideration, and during the electrical exhibition which is to be held at Taunton shortly, I have no doubt a stoppage at Bath will be included in the visit of all interested in the advancement of electricity as an illuminant. In course of time the Council will undoubtedly have to consider the advisability of increasing the number of lamps, by placing them closer together in certain thoroughfares which at present are insufficiently lighted."

The Speed of Electricity.—The experiments now in progress at M'Gill College, Montreal, under the auspices of the British and Canadian Governments, to ascertain the longitude of Montreal by direct observations from Greenwich, have led to the accomplishment of a remarkable telegraphic feat. The Canadian papers report it thus: "The first thing to determine was the length of time it took a telegraphic signal to cross the Atlantic. An automatic contrivance, whereby the land line could work into the cable, was provided, and a duplex circuit was arranged, so that the signal sent from Montreal would go over the land lines to Canso (Nova Scotia), thence over the cable to Waterville, Ireland, and return to Montreal again. Attached to the sending and receiving apparatus was a chronograph, which measured the time. Out of a couple of hundred signals sent, it was found that the average time taken to cross the Atlantic and back again—a distance of 8,000 miles—occupied a trifle over one second; the exact time being one second and five-hundredths. Prof. M'Leod, who is carrying on the experiments with Mr. Hosmer, the manager of the Canadian Pacific telegraphs, has left for Canso, where further experiments will be made. As soon as this work is completed, the Canadian Pacific Railway have offered their wires for determining the longitude and latitude of Vancouver, B.C."

Southampton Electric Cranes.—The Southampton Harbour Board last week had before them the draft agreement with the Southampton Electric Light and Power Company. It is proposed that the arrangement should continue for seven years, the Board guaranteeing a minimum payment of £200 a year. It was moved that this be adopted, but the period of seven years was objected, four being considered sufficient. Mr. Emanuel said that the company had stated the cost of plant would be £3,500, which at 20 per cent. would cost £700 a year, so that £200 was a small sum to ask. But the company were only entitled to charge 20 per cent. on the actual cost of conduit (£625), which would come to £125. He moved that four years be substituted. The chairman said there would be a central chamber at the bottom of the High-street, and the Board would have to take their motive power from thence to their own property. They were going to pay by meter for the motive power they required, but if the electricity used did not cost £200 a year, they would still pay that sum for the term specified. Mr. Emanuel was satisfied with the agreement, with the difference between seven and four years. The amendment was carried, as was also a further amendment that before the agreement was signed they should have a complete estimate of the whole cost.

Feeder Tramways.—An interesting venture in light feeder tramways was opened this month in India, and inspected by Major Pulford, R.E., for the Government, who expressed his satisfaction with the arrangements. The line, which is a steam tramway of 2ft. 6in. gauge, is laid along the public road, and the engines are capable of travelling at 10 miles an hour. The line extends from Shahjehanpore (where it connects at a joint transshipment platform with the Oudh and Rohilkhund Railway) to Khotar, a town six miles from Milani on the L. S. and S. Railway, the total length being 31 miles. The line was carried out by Messrs. John Fowler and Co., of Leeds, through their branch at 31, Dalhousie-square, Calcutta. These small feeder lines have attracted a considerable degree of attention, as being very important additions to the large trunk railways. We mention the matter to show that the question of light railways is ripe for business in India, and although this line is worked by steam, there is every indication that, properly pushed, there might be also a considerable field for overhead conductor electric feeder lines for passengers and goods. When it is reflected that in America electricity has proved itself cheaper than horses, and actually in some cases has ousted steam, it is evident that a very large field may naturally be expected in our colonies and India.

Sad Death.—We very much regret this week to have to record the death by drowning at Hampton on Saturday of Mr. W. G. M. Mackenzie, secretary of the General Electric Traction Company. Mr. Mackenzie, who had charge of the electric boat department of the company, was living at Hampton during the summer months. On Saturday morning he went for a bathe in the backwater at Hampton before breakfast, as was often his habit, this time with a friend, Mr. Clarke, who was staying on a visit with him. Mr. Mackenzie was seized with cramp soon after plunging into the river and struggled violently. Mr. Clarke swam to his assistance, but was unable to rescue him, and was almost drowned himself, being only just saved by a boatman in a light skiff. The body was not recovered till two hours afterwards. Mr. Macpherson, managing director, was telegraphed for, and attended the inquest on Tuesday. Mr. Mackenzie was unmarried, and only 37 years of age. He was appointed secretary of the company at the time of its conversion from the Electric Traction Company and Immisch and Co. He was universally respected by the company, and by everyone who had the pleasure of knowing him, as a straightforward English gentleman. During his previous life he had passed through many and varied adventures in the South Seas and other parts, often with hairbreadth escapes. His sudden death amongst the present peaceful surroundings has caused a great shock to all his many friends.

University College Engineering Society.—At a *conversazione* held in University College, London, on Tuesday, June 30th, the above society gave an exhibition of machinery, instruments, models, and drawings in the engineering laboratory. The temporary electric lighting was undertaken by the Keys' Electric Company of London. The light was given by four arc lamps, and an electrolier with six incandescent lamps, the necessary current being supplied by one of the firm's 10-h.p. dynamos working at 110 volts, and running from a Crossley gas engine indicating 8 h.p. at 250 revolutions. The installation gave every satisfaction. The firm also lent a very complete exhibition of electrical appliances. Messrs. Siemens Bros. and Co. and Messrs. Ferranti also gave a very interesting display of electrical instruments, as well as their electric cables. There were several steam engines, a Worthington pump, a small alternate-current dynamo, and a model of Brotherhood's three-cylinder engine and pump in motion; whilst numerous models and photographs of Joy's valve gear, Giffard injectors, Kennedy's water-meter, brickmaking machine, torpedo, Holden's liquid fuel injector, Donkin's sprung piston rods, gas exhauster, fourway valve, and Sulzer valve gear, Hero, Newcomen, and Savory engines, a cylinder of Robey engine, with automatic valve gear, represented various branches of mechanical engineering. The laboratory testing machine, capable of exerting a pull of 100,000lb., was described, and the method of testing demonstrated; numerous tests in tension, compression, shear, and bending being displayed. The method of testing cement was fully illustrated. The engineering laboratory formed a centre of attraction throughout the evening.

Teague's Meter.—We drew attention at the time of the St. Pancras Exhibition to a new electric meter invented by Mr. Francis Teague, of Acme Electric Works. This meter promises extremely well, and has great points of advantage. Several improvements have been made in details, and it is expected, we believe, that it will be ready for the market in a few weeks. The meter is a simple embodiment of Faraday's experiment. A magnet has a large hole pierced in one of its poles, and in this the other pole projects, leaving a thin space between the solid and hollow poles, having a most intense magnet field. In this a thin metal cylinder, which carries the current, rotates by reaction of current and magnetism. The cylinder is mounted on jewelled points, and gears into a worm with dials reading direct in B. T. units. The meter has received improvements in a metal frame to prevent all warping; also the rotation of the cylinder has been damped by suitable arrangements, so that its greatest speed now is about equal to 100 revolutions only in the minute for 50 amperes. The meter, one of which we saw tested, starts very slowly, but regularly, at a current of ·2 ampere, less than that required for an 8-c.p. lamp. The motion is very sensitive, starting immediately and stopping absolutely dead when the current is turned on or off. It has only one moving part—the cylinder—besides the train of wheels, and these move so slowly that there is not much danger of wear and tear. Both wheels and pinions are made of brass to prevent any inconvenience from rust in damp places. The only possible objection is the mercury contact, and the hole through which the spindle rests is so small, and is, again, closed in by the cover, that no dust could get in. It has been carefully tested, and is correct to within 2 per cent. the whole way up from 1 to 100 lamps. Teague meters are being tested at the Pall Mall, Westminster, Kensington Court, and Chelsea stations. We expect to hear more of this meter, which is simple and should be cheap.

City Electric Lighting Bill.—The Parliamentary Committee of the London County Council report with reference to the Bill granting a provisional order for the City of London. The Bill contains a clause authorising the transfer to a single company of the undertaking of the two companies (Brush and Laing-Wharton) authorised to supply in the City of London, and also the undertaking proposed to be authorised in the district of St. Saviour, Southwark, in which the station for generating electricity to be supplied to the City of London will be situate. It is obvious, says the Parliamentary Committee, that on any such transfer some complication may arise by reason of the fact that the County Council have the appointment of inspectors generally in the county of London, and the Corporation have the appointment within the City. Moreover, the enactments in the orders within the City do not in some respects correspond with those in force outside. A difficulty also would arise in connection with the question of purchase. As the time for lodging the petition expired on the day of our meeting, the committee sanctioned the presentation of a petition, which has accordingly been presented. The attention of the Board of Trade has already been directed to this clause in their orders, but think the clause should be retained, and have retained it, so that if the petition is proceeded with it becomes rather a question of opposition to the Board of Trade by the London County Council. The clause in question provides that any transfer under the terms of it shall be on such terms and conditions as the Board of Trade impose, and the committee understand that the Board of Trade think that this would be sufficient to enable them to deal with any question which might arise. The deputy chairman and the chairman of the Highways Committee have been requested to seek an interview on the subject with the proper official of the Board of Trade, and if satisfactory arrangements can be made, the petition may be withdrawn. In the meantime it was recommended that the course taken in presenting a petition against the Bill be approved.

City Lighting.—The Streets Committee of the Commissioners of Sewers at last week's meeting brought up a report recommending the Commission to consent to the proposed transfer of the undertakings in regard to the electric lighting of the City to a new company to be formed under the title of "The City of London Electric Lighting Company." Mr. J. L. Sayer, chairman of the committee, said that at the time the contracts were entered into it was known that they would involve an outlay of at least a million, and that the contracting companies would either have to borrow the money or form a syndicate. Mr. Morton, M.P., asked what promotion money was to be paid. They had had the experience of the Hansard Union, which was floated entirely upon the House of Commons contracts, and his opinion was that the name of the Commission had been sufficiently used already by the companies without it being further used for Stock Exchange purposes. Mr. C. T. Harris said he had ascertained that the Brush Company would receive £310,700, and the Laing, Wharton, and Down syndicate £237,000, from the proposed new company. He moved an amendment to delay the assent to the transfer of the contracts until more detailed information was forthcoming, urging that the provision for a reduction of the charges to private consumers when a 10 per cent. dividend was earned would be sacrificed if the capital was increased. Mr. Stapley seconded. Mr. Deputy Edmeston was surprised that such information should be needed when the committee were told by the managing director of the Brush Company that no money would be paid other than for materials and for work that had been done. Mr. A. A. Wood hoped that the consumers would be properly protected. The chairman said he could give the Court the assurance of the representative of the Brush Company that not a shilling was to be paid for goodwill except for works, etc., which were to be executed. Mr. Cloudesley thought that further information should be given. Mr. Morton asked whether anyone connected with the Commission was connected with any company; he saw the name of the Lord Mayor and Messrs. Pannell and Co. on a document. He was glad to see that the Lord Mayor had withdrawn his name. Mr. Pannell said his name only appeared as an auditor. In reply to Mr. Shaw, the solicitor stated that the position of the Commissioners would be in no way prejudiced by the proposed transfer. The amendment was put and lost by 18 votes to 24, and the report was agreed to.

ARC LAMP STANDARDS.

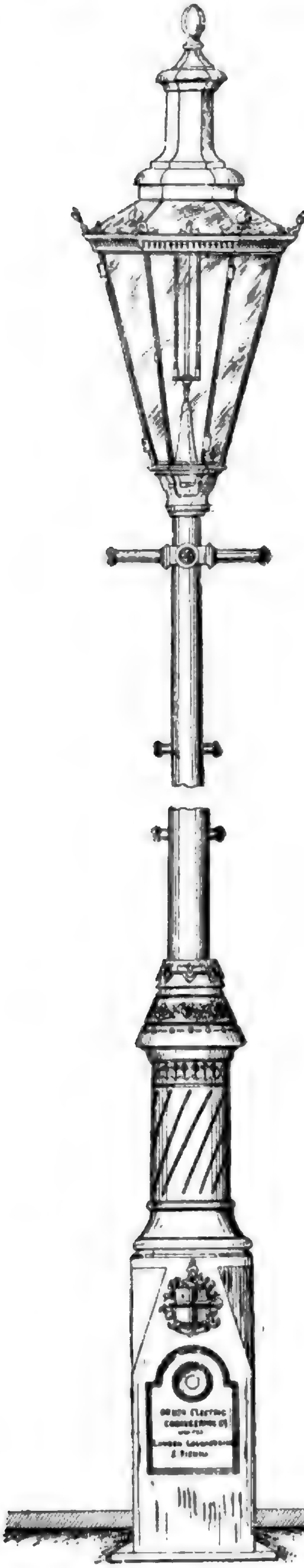


Fig. 1.

It is known to our readers that a number of arc lamps have been installed in the City in order to obtain opinions as to the suitability of the standards for such lighting. Many people are of the opinion that the present opportunity is unique in character, and the time will not recur again, in our day at any rate, when the design and construction of standards can be made worthy the lighting of the greatest city the world has ever seen. A mistake too frequently made is to think that beauty of form and

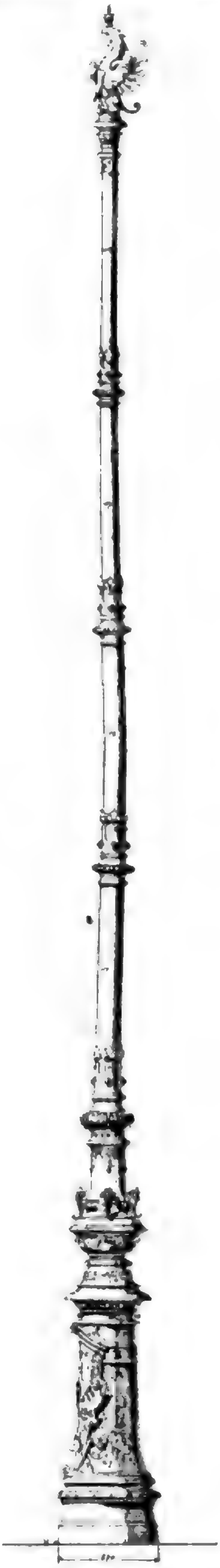
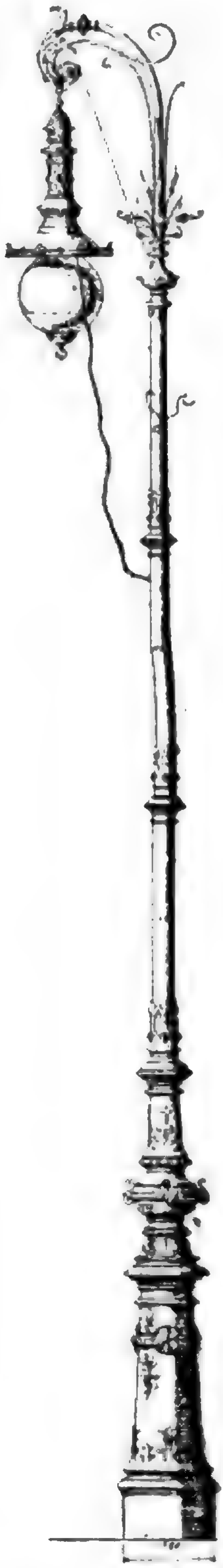


Fig. 3.



ig. 4

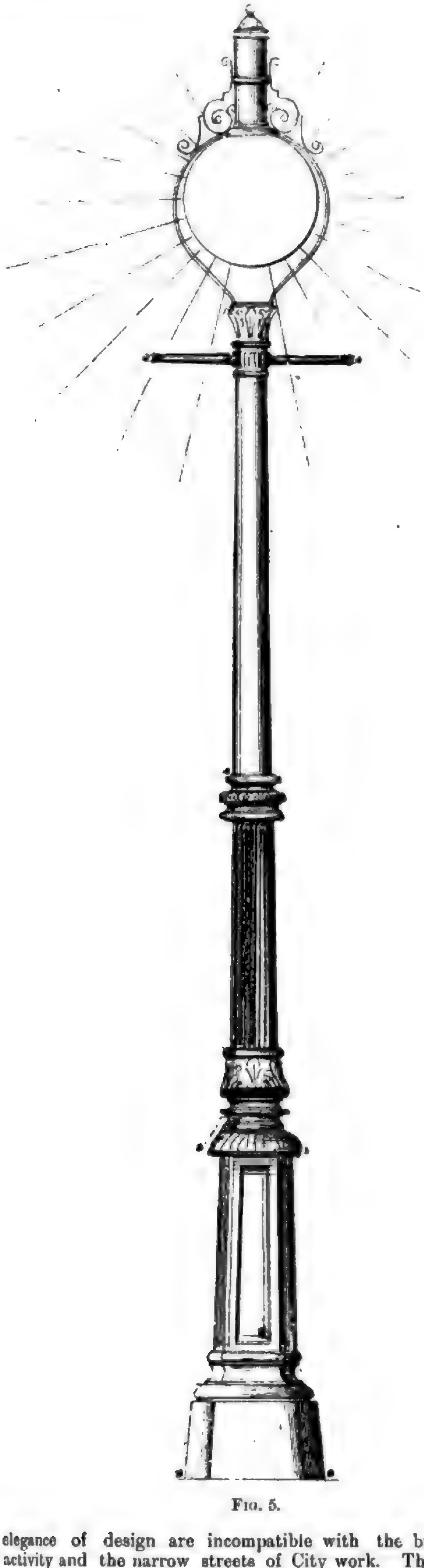


FIG. 5.

elegance of design are incompatible with the bustling activity and the narrow streets of City work. The idea that "anything" will do must be negatived, and a good example must be set to those towns that follow the lead of modern Babylon. We are amongst those who believe the engineers have not quite realised the possibilities of the case, and the temporary standards, as erected, seem a little deficient in artistic merit. An illustration of the standards erected in Queen Victoria-street hardly meets the case. They ought to be seen *in situ* to be able to decide as to their design. However, so far as illustrations will assist, we herewith give various designs of arc lamp standards. Fig. 1 shows the standard as erected in Queen Victoria-street by the Brush Company. To us the knobby excrescences are an eyesore, and rather put us in mind of an antediluvian ladder; the ornamentation and proportions of the base are also crude and inartistic. With the head of the standard we have not much fault to find, either as in Fig. 1 or as in Fig. 2, the latter of which shows the head of the standard as proposed for the portion of the City to be lighted under the Laing, Wharton, and Down Syndicate. The base and centre-piece of both standards are the same. Figs. 3 and 4 show the standards as used in Berlin; Fig. 5 is a design for a standard for the City, by Mr. W. Doubleday, of Birmingham, as is also Fig. 6.

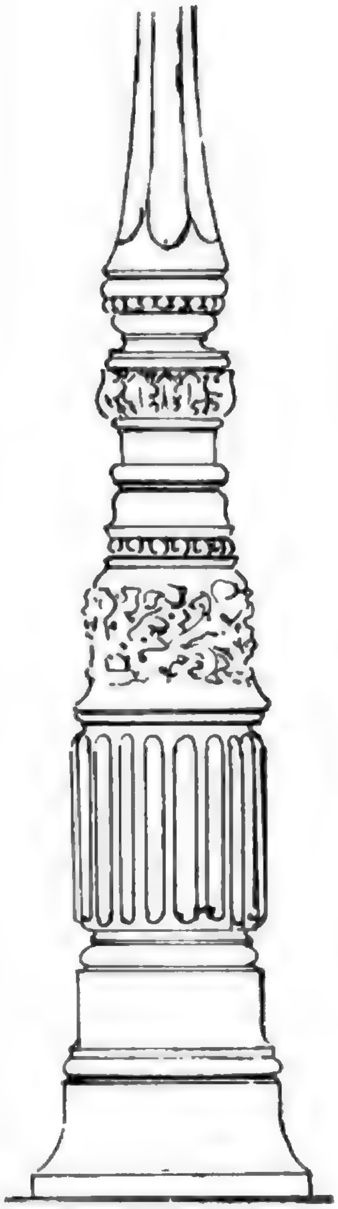


FIG. 2.

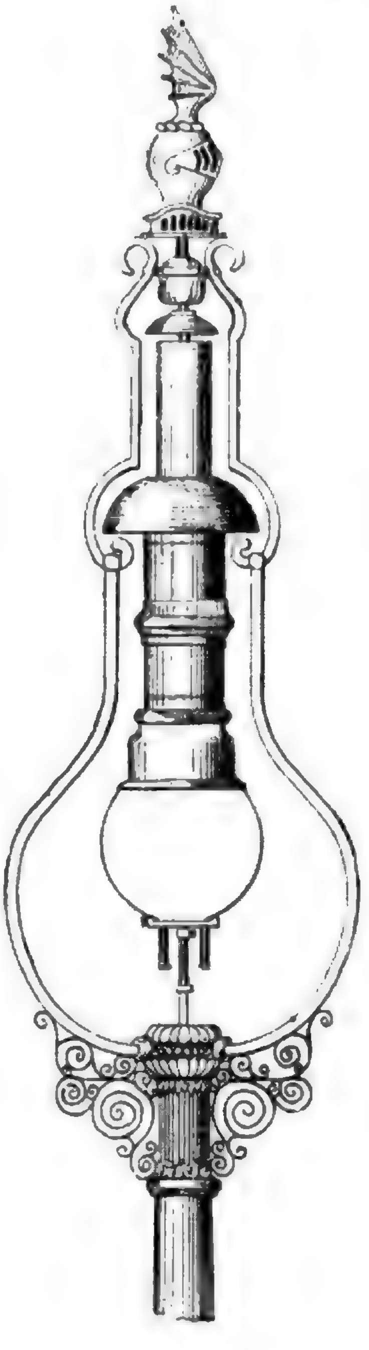


FIG. 6.

Alhambra.—At the performance of "Oriella" at the Alhambra, all the ballet electric effects have been carried out by Mr. Chas. S. Northcote, engineer to Messrs. B. Verity and Sons.

THE ROYAL AGRICULTURAL SOCIETY'S SHOW AT DONCASTER.

We have already directed attention to the prominence of oil engines at this show. In other directions the visitor could inspect motors of the most approved type, and possessing all the improvements known to the manufacturers up to date. Of purely electrical apparatus there was little to be seen. The engineers of the society, Messrs. Easton and Anderson, used a Prentice dynamo and motor, constructed by the firm, to carry on the trials in the dairy.

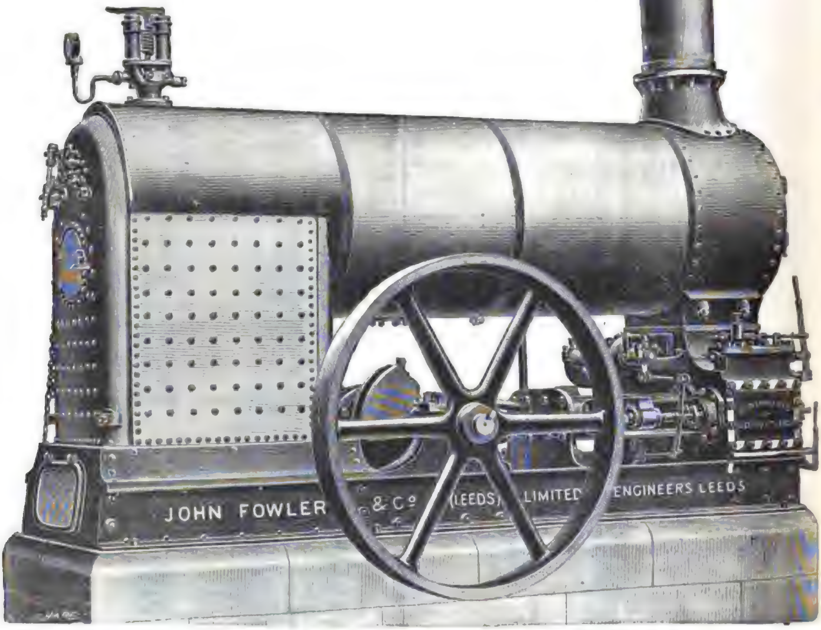

JOHN FOWLER
& Co
(LEEDS)
LIMITED
ENGINEERS LEEDS

Fig. 1.

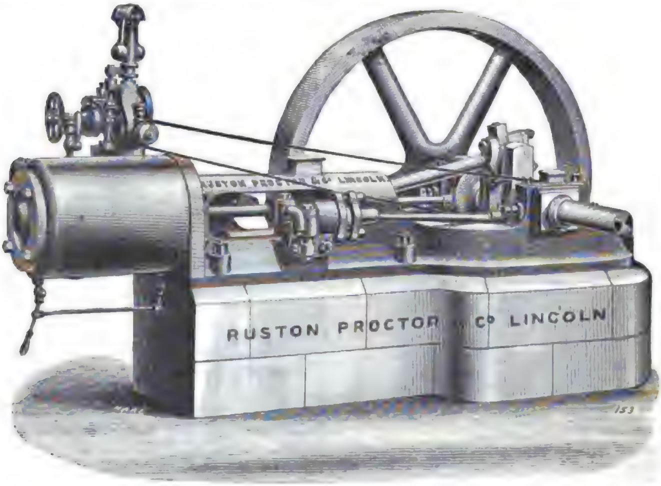

RUSTON PROCTOR & Co LINCOLN
RUSTON PROCTOR
Co LINCOLN

Fig. 2.

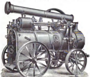


FIG. 3.

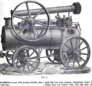


FIG. 4.

So far as we were able to judge, the apparatus was well adapted to the purpose, caused no trouble, and got rid of much objectionable shaking, enabling the trials to be carried on at any desirable point with greater facility than has usually been the case.

The Hardy Patent Pick Company exhibited a magnetic separator, used for the purpose of extracting iron from among crushed bones, ores, etc. The separator was, we believe, constructed by Messrs. Goolden, and was under the charge of Mr. Atkinson. The separator is conically shaped, with soft iron bars running longitudinally down the interior. These bars are wound with wire, the ends of which are carried to a commutator. The material to be treated is fed into the small end of the apparatus, which revolves upon four friction wheels, and gradually passes down and out at the larger end. During the passage the material comes again and again into contact with the magnets, and any iron becomes attached to them. The iron is carried round by the magnets, and as the action of the commutator breaks contact just as the magnets rise over a shelf, the iron drops off upon the shelf. The material traversing the cone comes about a hundred times into contact with the magnets, so that there is little probability of a piece of iron getting away.

Messrs. Christy and Carter's separator was also shown, but this apparatus needs some improvement before it can be said to be perfect.

Of engines portable, semi-portable, and horizontal, there was a fine display. Most of these engines are of the well-known types of the manufacturers, and call for little comment. Fig. 1 illustrates a semi-portable engine of Messrs. John Fowler and Co., of Leeds. Like most, if not all, of these makers' engines, Hartnell's gear is used, and the governing is such that the variation of speed is not more than 1 or 2 per cent. between full and no load. Fig. 2 shows a fixed engine by Messrs. Ruston and Proctor, and Fig. 3 a portable engine by the same firm. Since last year's show Messrs. Ruston and Proctor seem to have incorporated several improvements, the principal of which are the enlargement of the cylinder and of the firebox, so that a recent 8 h.p. is about equivalent to an old 10 h.p., with the advantage of a reduction in cost. Fig. 4 shows a portable engine by Messrs. Clayton and Shuttleworth. The workmanship of all these engines is the best possible.

(To be continued.)

THE NAVAL EXHIBITION.

The exhibit of the T. G. Electric Power and Traction Company, Limited, Malden Works, Kentish Town, London, N.W., at the Naval Exhibition represents admirably the varied classes of work carried out by this enterprising company. It comprises both ship plant and general installation work, and shows some interesting examples of the application of electric power to machine tools and other purposes; whilst by no means the least useful part of the exhibit is a set of three-throw high lift ram pumps run by one of the company's mining motors, and a small fan coupled direct to the shaft of a motor shows a cheap, efficient, and noiseless means of ventilating crowded halls and theatres. The stall is brilliantly and tastefully lighted by a number of frosted 16-c.p. incandescent lamps in artistic fittings, many of which are especially suited for use on board ship. These lamps are run off a combined engine and dynamo, which at 320 revolutions per minute gives an output of 150 amperes and 80 volts. The plant is specially designed for use aboard ship, and conforms to the Admiralty requirements as regards heating, direction of runs, etc. On the same circuit are run the motors for driving pump, fan, tramcar gear, and machine tools. A motor and gearing similar to that used at the North Metropolitan Tramway Depot at Canning Town and the Liverpool Tramway Company is also shown running. The motor has a cylinder armature and gives 10 brake horse-power at about 900 revolutions per minute when supplied with current at 190 volts. The armature is cased in at either end; the brushes are of carbon, in holders of a specially arranged type, patented by the company, and used most successfully by them for motors of all descriptions. The gearing consists of two transmissions, and the high-speed pinion is built up of fibre. In practice it is found that tramcars with this gear make less noise than ordinary horse-cars. The same form of motor truck, slightly modified, is used by the company for light railways.

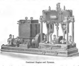
A machine worthy of special note is a portable drill, with radial arms, capable of drilling holes up to 1½in. in iron and steel. This machine is driven by an Immisch ½ h.p. motor, and is an admirable illustration of the portability of electric tools. It is as convenient in every respect as an ordinary power drill, and combines the further advantage of portability.

A set of three-throw pumps illustrates the company's method of applying electricity to high-lift pumps in mines. Some dozens of these plants are now at work in different parts of Great Britain, the Continent, and the colonies, and in all cases they have given the highest satisfaction, realising a high efficiency with a minimum attention, cost, and wear. The parts are so simple, and the general details so well throughout, that breakdowns are of rare occurrence, and owing to the interchangeability of parts such accidents are easily guarded against.

On the stand is also an Immisch launch motor with patent ball-bearing thrust block, such as is used by the company for general boating work. The machine is light, compact, and efficient, weighs about 300lb., and develops 5½ brake horse-power at 800 to 900 revolutions per minute. Some interesting examples of high-speed propellers are also shown, which serve to mark the advance the company have made in this branch of their work.

The boat switches fitted with three levers—one for starting and stopping through a resistance, one for full speed and half speed, and the third for running ahead or astern—are compact and workmanlike, and have now stood the test of two seasons' experience.

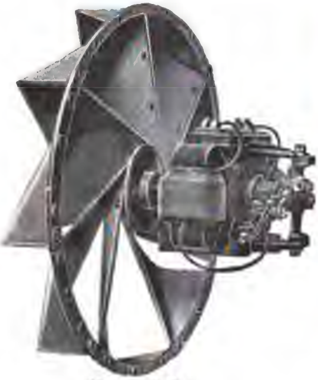
In the grounds just outside the Camperdown Gallery the

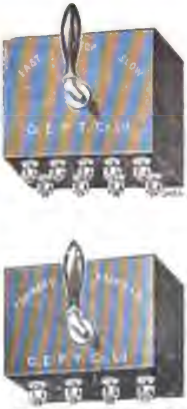


Combined Engine and Dynamo.

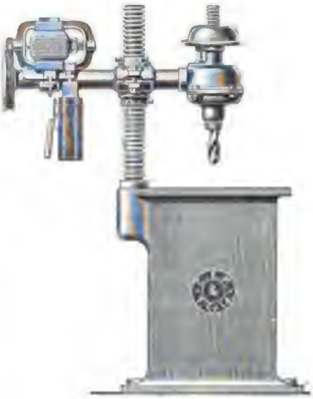
company has an electric pannace designed on the lines of the Admiralty steam pinnaces. It is 36ft. long, 7ft. beam, with a maximum draught of about 2ft. It is built in pine with oak stem, stem and stern posts, and is bright all over. The accumulators, 50 in number, are arranged in teak boxes under the seats, and are so placed as to be easily removable when necessary. The whole is so strongly built that by suitable arrangements the pinnace can be slung on davits with all electrical equipment ready for use. The cells can be charged either with the pinnace slung in the davits or moored alongside the ship. The motor is much more powerful than those usually supplied by the company for use in the launches on the Thames and at Windermere, and a speed of 11 miles per hour can be obtained for some three to four hours. Since these boats are principally used for shore purposes, speed and power have been considered of more importance than duration of run. For shore and harbour pinnaces electricity possesses many advantages over steam, and they no doubt will be largely in demand before long. These launches are ready for use at a moment's notice, and possessing none of the disadvantages of steam as regards dirt, smell, and heat, commend themselves to the consideration of all. One of these pinnaces, 40ft. long, 7ft. 9in. beam, and 2ft. draught, with a handsome teak cabin, is now being built by the T. G. Electric Power and Traction Company to the order of the Naval Department of the Russian Government; it is expected that this launch will give fully 11 miles per hour. The company have demonstrated the sea-going properties of these pinnaces; they find them to have a very steady motion even in a fairly high sea, and the centre of gravity is so well placed that the rolling is little. The motor having no reciprocating parts, runs more smoothly than a high-speed engine—this advantage will be specially felt when there is a tendency to racing of the propeller; and the whole of the electric details have been so well thought out and proved by actual experience, that there is no fear of a hitch. Since the motor and accumulator are all arranged beneath the floor and seats there is more room and greater comfort for passengers, and the carrying capacity of a given size boat is increased by about 50 per cent. The small torpedo boat running on the lake at the Naval Exhibition has been equipped by one of the company's launch motors, and the company have just received an order to build and equip a second boat of similar dimensions. The headquarters of the company's boat department are at Platt's Eyot, Hampton, where different-size launches can be seen and inspected by those interested.

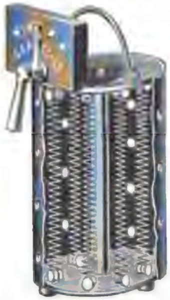
There are many other interesting things to be seen at this stand, but we cannot enumerate them here; a visit should be made.

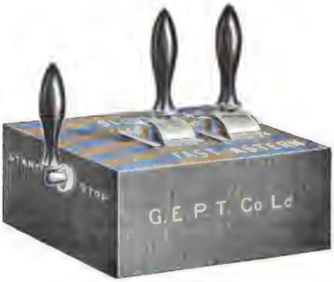

Motor and Fan.



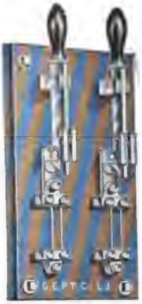
Electric Launch Switch.


Electric Drill.


Resistance.



Electric Launch Switch.



Switch and Fuse.

The Telautograph Again.—Prof. Elisha Gray, the noted electrician of Chicago, will give a public exhibition in July of the latest invention, the telautograph, which (says a New York telegram) is destined to revolutionise telegraphy. Prof. Gray perfected the invention in 1889, after working on it for seven years, but kept the secret until the patents were secured. The instrument not only transmits the message a long distance by wire, but reproduces at the receiving point a perfect facsimile of the message as written. Pictures and diagrams may also be transmitted. The instruments will be manufactured at Highland Park, a suburb of Chicago, and branch lines will be established throughout the country.

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MUNICIPAL ENGINEERS.

One of the most important duties of municipal engineers in the immediate future will be to watch for and advise their respective authorities upon the introduction of electric light and power. A good deal of friction has in the past arisen between supply companies and local authorities. Each party was fighting for its own hand, and neither saw any common ground of action. It has been well said that as men grow older they grow wiser. The same holds true of those who promote new industries. Filled with enthusiasm at first, they imagine that everyone to whom they go should rush with alacrity to embrace the chance of displacing the old by the new. David's decision about the sword is too often forgotten. He would not use it because he had not tried it. The promoters of a new industry have the same feeling to contend against. Proof, in some way or other, must be given as to the advantages said to be obtained. The technical advisers of local authorities—that is, their engineers—knew little of electrical matters, and the exponents of the new departure knew little more. The latter had something which they swore by, but of its capabilities knew nothing. All were learners. For a time their progress was naturally slow. Satisfactory proofs gradually accumulated, and now greater activity prevails, while the outlook points to still greater development. The municipal and county engineers are therefore buckling down to the task of learning all they can about electrical progress. At their meeting last week several papers were read dealing with electric lighting from the municipal point of view. The most important of these is the address of Mr. W. H. Preece, F.R.S., which goes straight at the crucial point of the whole matter—its cost. Mr. Preece's conclusions are that the electric light has been vilely calumniated, and that instead of being the rich man's light, it is really the poor man's light. Once convince municipal authorities that the cost of this artificial light is not that of a luxury all will be plain sailing, for it is evident to the most sceptical mind that its other advantages are overwhelmingly in its favour against any other artificial illuminant. From many points of view gas might have been termed a diabolical invention. It is always dangerous—not openly, but insidiously so—although interested parties are ever commenting upon the smell preventing accidents; whilst with electricity there is no such danger signal. We have always held that the danger from explosion is the least of the dangers from gas. Its leakage propensities in minute quantities probably cause more headaches, more depression of spirits, conduce more to the lowering of tone of the system, and putting it in a condition to contract any prevailing epidemic, than all other causes combined. Putting, however, these questions aside, the municipal engineers have a solid substratum of data as regards cost to consider. Their visit to Ferranti's central station, to the City and South London Railway, would initiate them into the ractical part of the work. In this direction the ifficulties encountered have been neither few nor imple, but for the most part have been successfully vercome, so that half a dozen or half a score of ngineers would readily provide plans for the lighting f any town in the kingdom—plans which if carefully arried out would lead to perfectly trustworthy and atisfactory lighting.

VESTED INTERESTS.

The decision with reference to the Birmingham electric tramways and the telephones shows conclusively that the telephone companies will fight under the ægis of "vested interests" to obtain the monopoly of "earth return." The man in possession is a most difficult individual to deal with. Morally, his right may be objectionable, but practically he laughs at all opponents. The "earth" as a return seems naturally to come under the head of common property, just as the air we breathe; but currents do interfere with each other, and no doubt heavy currents, such as are used in tramway work, or in lighting, cannot use the same earth as telephone or telegraph currents. The case stands thus: In many places telephones have been installed, and in the majority of instances, when installed, the earth is used as the return part of the circuit. The telephone companies are private adventure concerns, and whatever profits arise go into the hands of shareholders and are not common property to the whole community like telegraphic profits. A part of the profits is paid in the shape of royalty to the Telegraph Department, and so may be looked upon as a benefit to the community, but otherwise, as we say, the adventure is one of a purely private character. Tramway work, electric lighting, electric transmission of power, are also private adventures, and from the moral point of view these adventures have just as much right to use an "earth return" as the telephone.

In no case, however, is an earth return better than a metallic return, and it is only used to save money; and this, so far as telephony is concerned, is usually saved at the expense of time and temper. The best telephone circuits are those wholly metallic. It is argued, however, that initial saving is of the utmost importance in the early stages of an industry, and that the development of telephony would be greatly retarded by insisting on the use of metallic circuits Some eminent telephone engineers dispute this, and contend that in all instances the complete metallic circuit is the best.

At Birmingham the tramway company desired to use the earth as a return, but the telephone company objected, and has won the day, in that the tramway company will have to incorporate in its Bill a clause to use a return wire. The shareholders of the tramway company, being mostly local people, are rather nettled at this decision, and a good deal of correspondence has taken place on the subject in the local Press. It will be seen, however, that the question is wider than Birmingham, and must be decided upon the wider basis. Are we to recognise the principle of "vested interests" wherever a telephone wire is installed, or is earth to be "common property," or is it to be reserved solely for the nation—*i.e.*, for the Post Office?

UNDERGROUND ELECTRIC RAILWAYS IN NEW YORK.

The question of rapid transit has been one that has been agitating the minds of engineers and municipal authorities in New York not less than in London itself. The overhead railways above the streets have made their unpleasantness abundantly felt in spite of their convenience, and further rapid transit was hardly to be looked for in this direction. Street railways with overhead conductors are equally objectionable in a large and crowded city, conduit systems have not yet shown their practicability on any scale (though they seem to promise well in this country), neither have storage cars demonstrated their absolute efficiency and economy on the scale desired. There remained the underground tube electric railway, which, without disturbing the street, has been shown by the City and South London line to give a desirable solution of the problem in point of rapidity and safety, as well as facility of obtaining the necessary space for new railway lines without encroaching on the streets. We learn that after considerable discussion, which has been going on for some months, it has just been decided to put down 20 miles of this underground tube electric railway to serve from the business part of New York to the west end suburbs. We believe it is not at all improbable, also, that a similar railway will be undertaken to give communication for the east end district.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

BATH.

Sir,—On January 30 you published among your notes the following:

"Bath.—We are glad to learn that considerable and gratifying improvements have taken place at the Bath central station. The festoons of wire and other temporary arrangements that made this station somewhat like a Yankee station have given place to the neatness and solidity that should distinguish English engineering work. The high-potential terminals also—previously a source of our complaints—are now covered in with glass and out of harm's way, and matters have smoothed over considerably since the new chief engineer took up his work there"—implying that I had left the station in these particulars in a "temporary" and "Yankee"-like condition, which I deny.

By a remarkable coincidence that number of your paper never reached me, and the above was only brought to my notice a day or two ago.

At the date of your note, and for some time afterwards, the wires were in exactly the same condition as I left them a month before, as were also the switchboards, with their high-tension terminals. Therefore "the considerable and gratifying improvements" mentioned were carried out by me, and not by the new engineer, as stated.

I much regret your inability to give the source from whence you obtained the above information, but trust you will recall these imputations against me by publishing this letter.—Yours, etc.

GEORGE S. HOOKER,
late Chief Engineer of the Bath Central Station.
184, Evering-road, Clapton, N.E., July 1, 1891.

COST OF LIGHTING BY GAS AND BY ELECTRICITY.*

BY W. H. PREECE, F.R.S.

I have the pleasure this morning of bringing before you the subject of the relative merit and cost of gas and electricity for lighting purposes, and as a practical man, speaking to practical men, I propose to consider the subject solely from a practical point of view, and to deal rather with the financial aspects of the question than the mere technics. Of course I shall have to deal a good deal with figures, and figures are proverbially dry. It has been said that you cannot extract a joke out of figures, and that you can always manipulate figures to suit your own particular view. Neither statement is quite true, because we have all of us heard the old story about the two men contesting with each other, and one man saying: "Why, sir, it is as plain as two and two make four," and the other man saying, "But two and two don't make four; two and two make 22." And, again, as to manipulating figures to suit one's own purpose, I dare say it will be said I am going to do very much that kind of thing myself. I am addressing you, if I have any prejudice at all, as a gas shareholder, and not as an enthusiastic electrician. Comparisons of cost are generally fallacious, because the comparison depends so very much upon the point of view taken. The questions we have to decide are principally such as these: what is the capital involved in any particular industry; what is the profit derived, and what has the consumer to pay? I am not going to bring before you any fanciful figures. They are published figures, and they are figures you can all get for yourselves, and you will be able to check the deductions I am going to make. I have taken the case of Manchester for the simple reason that I have more authentic records of what is done in Manchester than I have of what is done in any other town. And, from the records of the gas department in Manchester, it seems that one ton of coal in Manchester produces 9,611 cubic feet of 20-c.p. gas. I take Manchester also because it is above the average—20-c.p. gas is rather in excess of the average of the country; the average of the country is not more than 15 c.p. Since this is the quantity of gas produced by a ton of coal it follows that 1lb. of coal will produce 4·29 cubic feet of gas, and if 4·29 cubic feet of gas is burnt per hour, we get in Manchester an illumination of 17·2 candles. Now, in drawing a comparison between gas and electricity, I must use one technical term—and I think it probably will be the only technical term I shall use—and it is a technical term which is now coming into very general use, and will have to be understood by every engineer, whether electrical or municipal—that is, the term *watt*. A watt is the mechanical unit of power. The common unit of work with which we are most acquainted is the foot-pound, and the unit of power we know best is the *horse-power*—that is, the power exerted that will raise 33,000lb. one foot per minute. In other words, you may say a horse-power is the power which will raise 550lb. one foot per second. The watt is that power which in the metrical system will raise—I forget the exact value in grammes per centimetre, but it is that power which is exerted by a current of one ampere flowing through one ohm for one second. It enables us exactly to tell you how many lamps will be lighted and what light they will give. So in the use of electrical energy, if we burn in a steam boiler 7lb. of coal per hour, we shall produce 1·3 h.p. of electrical energy, or represented in watts we shall produce 1,000 watts, and 1,000 watts is called a kilowatt. So 7lb. of coal will give us a kilowatt-hour of electrical energy, and I will show you what light it will give. In the same way that I have shown that 1lb. of coal distilled into gas will produce 4·29 cubic feet, or 17·2 candles of light, so 1lb. of coal burnt in a boiler to produce steam will give us electrical energy that will give the following—I will show it in two forms: one *the arc lamp*, which we use in our streets, and the other *the glow lamp*, which we use in our houses—1lb. of coal burnt per hour, and used as electrical energy, if burnt in the form of a glow lamp will give 48 candles, and if burnt in the form of an arc will give 288 candles. So here we start with the first theoretical fact that I bring before you, that 1lb. of coal distilled into gas in Manchester gives us a candle-power of 17·2, if converted into electrical energy in the form of a glow lamp 48 candles, and in the form of an arc lamp 288 candles. That is theoretical; we will now come to hard facts. In Manchester, during the 12 months ending March 30th, 1890, the income derived from gas was £434,351, the expenditure was £360,804, showing that in Manchester a balance of £73,547 was derived from gas. That balance was devoted to meeting interest on loans, depreciation on plant, and the cost of public lighting. But from that fact I derive this: that the cost per 1,000 cubic feet of gas to the Corporation of Manchester was 2s., and therefore it costs the Corporation of Manchester 2s. to produce 4,000 candles of light. For the next point I am obliged to use an estimate for the simple reason that at present the Corporation of Manchester have not established a central electric light station. They have obtained a provisional order so as to enable them to do this, and they are now considering whether they shall carry it out themselves or transfer their powers to another body. In making an estimate of the cost of electricity in Manchester, we have to take the experience of the cost of manufacturing electricity elsewhere, and on this point there are at hand more reliable, accurate, and truthful facts than perhaps anything else connected with electricity. The Board of Trade exercise such a powerful control over the electric lighting interest, that there is no "hanky-panky" with the accounts. The accounts of expenditure must show the cost of production, and these are within the reach of everyone. My own experience of electricity is a pretty extensive one, for we have a great many of our post offices lighted with the electric light, and I have a central station at the General Post Office, which if you had not your bill full I should have been tempted to invite you to see what we are doing; we have a very large plant and we are going to produce in St. Martin's-le-Grand sufficient power to light 10,000 lamps, besides which we are laying down another plant at Coldbath Fields, where we shall generate electricity for another 10,000 lamps—and from my own experience I can say we can produce a kilowatt, or a Board of Trade unit, for 4d. This means that if we can produce 4,000 candles by gas for 2s., we can produce 4,000 candles by the arc lamp for 8d., and we can produce 4,000 candles by a glow lamp for 4s. So you see, on these facts—I am not calling them estimates, for they are facts—on these facts, the theoretical estimate of light produced is twice as much by the glow lamp as by the gas lamp. However proud we, as gas engineers, may be of producing gas of 20 c.p., when you come to the houses and shops of the users and consumers you find this 20 c.p. is very considerably diminished. This is a very important question, and one which some six or seven years ago concerned us at the Post Office very much, and Mr. Vernon Harcourt, F.R.S., and myself devoted considerable time to experiments on this question. Mr. Vernon Harcourt—who is a very painstaking, careful, and accurate experimenter—found, taking the ordinary burner, supposed to be consuming 5ft. per hour and giving 15 c.p. in London, really gives only 10 c.p., due partly to dirt in the burners, but principally to the flickering of the light of the gas, caused by draughts of air in the room. So, while a light burning in a special burner in a laboratory may give 15 c.p., when you come to a room or passage that lamp will only give 10 candles. This *pro rata* value is equally true of Manchester as of elsewhere. The result is you must add 30 per cent. to the cost of the gas for your 4,000 candles. This is another point. I ought also to say this depreciation in the value of light is not only true in the case of gas, but also true to a certain extent in the case of electricity. The lamps when they are still fresh and new give 16-c.p. light, but after they have been used 200 or 300 hours there is a peculiar effect of the electricity flowing through the carbon filament that causes the carbon to evaporate—it flies away in straight lines and is deposited on the glass bulb, obstructing a certain amount of light. Again, you have a certain amount of dirt and dust collected on the outside. The consequence is you have a depreciation in the amount of your electric light, though not quite so much as in the case of gas. I ought to mention, without drawing any distinction between the light-giving power—whether electricity or gas—in the light given by each, that five cubic feet of gas will give practically 10 c.p., and 33 watts in the normal power will give you also 10 c.p. There is one element of loss in gas that is very serious indeed—that is, the tremendous waste of gas that occurs through lights being left burning unnecessarily. Persons who have their houses and offices lighted with gas know that servants, as a rule, go and light all the burners, unless a careful householder goes round and cuts off those that are not wanted. The result is this: from this very element of waste there is 20 per cent. of gas used more than is necessary. This fact is brought out thus: taking the nine principal towns in this country, and taking the average numbers of hours of gas and electricity burnt in this country, the average number of hours for gas is 600, while the average number of hours for electricity is 460. The figure 460 is taken from the average of 200,000 electric lamps which are now alight in London. While in gas you have a tremendous waste from these burners being left flaring, you have no waste from electricity. Electricity is so easily lighted—a tap turns it on and off—that there is a species of instinct that teaches everyone that you only want your electricity alight in the place where you are using it, and at the moment you are using it, and the result is you get no waste. The result of it all comes to this: that the comparison between gas and the glow lamp is not 2s. as against 4s., which is theoretical, but the practical figure of 3s. 8d. against 4s. We can prove this. The average amount, taking the returns from the chief nine towns of this country, paid per gas burner per annum is 9s.; the average price of gas being 3s. per 1,000ft. The average price of the 200,000 electric lamps burning in London is 10s. So we have these two facts. That the average price paid per burner by the consumer for gas is 9s. per annum, the average price paid by the consumer to the electric light provider is 10s. This is a rather startling figure, because most people are under the impression that the cost of the electric lamp is very much greater than that of gas, and I have been myself very much surprised that the price I pay in my own house, where I generate my own electricity and have done so for the last eight years, was so very small. I find, although I have a gas engine and accumulators and have over 70 lamps, I am not paying more than when I had gas burners. I have taken all the companies in London, and have tabulated the revenue derived by each company per lamp per annum, taking the 33 watt lamp and the 10-candle burner. The Metropolitan Electric Supply Company derive a revenue of 12s. per lamp; the Chelsea Electric Supply Company, 8s. 6d. per annum; the Kensington and Knightsbridge, 9s. 2d.; the House-to-House Electric Supply Company, 11s. 6d. per annum; the St. James's and Pall Mall Electric Supply Company, 9s. 6d.; and a company, not in London, but in Brighton, obtains 8s. 6d.—the mean for 200,000 lamps being 10s. I have also verified myself this ratio between the two. In the General Post Office, where we burn a great quantity of gas, and where night operations are extended to late hours, and begin at early hours in the morning, there, from the experience of two years' working and comparison, we find that gas costs 18s. per lamp, and electricity 22s., so the ratio there is one of 9 to 11, and not of 9 to 10. Take the case of Manchester, where gas is cheaper than in other towns. The average price paid per lamp for gas in Manchester is 7s. 6d. per annum, while taking the cost of electricity to the consumer at 5d., the revenue that Manchester will derive from electric lamps will be 8s. 4d. Of course the rates of charges vary very much in London. The private companies are charging 7¼d., in other instances 8d. In Bradford they commenced by charging 5d., which they have since raised to 6d. In Newcastle they are charging 4½d. to the public, and they are allowing a large discount on that price to the large users of electricity. We in the Post Office are large users, and we have a discount of 20 per cent. off that 4½d., which makes the cost of our electric lighting in Newcastle very nearly approaching that of gas. In factories where they have isolated installations all facts show that electricity is cheaper than gas. I have figures from Bolton—from Messrs. Horrocks, Crewdson, and Co.—who are very large employers of labour in the district. They have had the electric light going for six years, and while they were using gas the cost per burner per annum came out at 5s. 6¾d. Since they generated their own electricity it comes out that their lamps cost 4s. 0¼d., so there is a considerable reduction. Those who know Manchester know that under the Exchange there is a large restaurant, which used to be unbearably hot when lighted with gas. The manager two years ago replaced gas by electricity, and he finds he is not only saving £800 a year in cost of illumination, but has probably doubled his income by allowing his guests to have their meals in comfort. So far as figures go, I have given you hard facts to show there is not much difference between the cost of electricity and that of gas. I tell all my friends that my house is lighted by gas, but I burn my gas in the garden, and allow all the vitiated gases to disappear in the air, while I extract from the gas what I want—light, and have it in the house free from all impurities. If you take 25 cubic feet of gas and burn it direct, you will only have 50 candles of light with a 10-candle burner, whereas if you burn your 25 cubic feet of gas in a gas engine, and convert it into electrical energy, it will give you 160 c.p. in the house. So, with a little care, you will be able to use the same gas and treble the amount of light in the house. I see in the programme you are going to the Royal Naval Exhibition. The Royal Naval Exhibition is lighted by electricity. There is an engine-room fitted up there with probably the latest developments of electrical machinery, for electrical machinery is constantly changing; we are daily producing improvements of some kind or other. The electrical room is well worth your visiting, and you will see there how the electrical energy is generated, and you will probably find that one dynamo and one engine is supplying the electric current to the whole of the exhibition. On Saturday you are going to have an even more interesting visit to the works of the Electric Supply Corporation, at Deptford. They are not completed, but there you will see preparations that are being made for lighting one million lamps in London. At the present moment there is only sufficient machinery to allow 200,000 lamps. You will be able to see there the space required for electrical machinery to light a million lamps. One of the great merits of electrical machinery over gas machinery is the small space which it uses. Gas requires 100ft. by 50ft. for every million cubic feet per annum; 100ft. by 50ft. is quite sufficient with electricity to light up one of our big towns. We must not neglect other points. We must not neglect the fact that when we deal with electric lighting we are removing from our midst a source of deterioration to our goods, chattels, and pictures; we are removing something which destroys our decorations, and dirts our ceilings; we are introducing into our houses something which encourages cleanliness; we add materially to our comfort, and by adding to our comfort we add very much to our cheerfulness. I know nothing which adds so much to the cheerfulness of our lives as the electric light. I feel it will even add to our lives. I feel that if I had not had the electric light in my house for the last eight years I should not have been addressing you to-day; and I hope when you meet in London 10 years hence I shall be able to come and address a larger body (for you will then be electrical engineers also), and give you experience of the progress and improvements which have been made. Another point is, that it adds so much to the security of our buildings and of our houses. It is not absolutely safe; it would be absurd to say it was. Carelessness and folly will cause fire by electric current as by gas. It requires supervision and the usual care that engineers know so well how to exercise. But it is this question of health which I want to thrust down everybody's throat as the great merit of electric lighting, even if the price were very great indeed. We find in the Savings Bank Department of the General Post Office the cost of the electric light is actually paid for by the increased service we get out of our staff. The electric light has diminished the hours of sick absence two hours per head per annum. That put down at 10d. per hour, which is the ordinary overtime rate in the Government service, means we save £680 per annum. Our electric light costs us £700 per annum, so our electric light is really costing us only £20 a year. In the General Post Office itself we succeeded in putting in the electric light just before Christmas, and the Chief Controller told me the electric light enabled them to do their work quicker than ever before, and that the light was equal to 200 men. The purity of the air you breathe, the sanitary aspect of the electric light, is the point and aspect which commends it so much to municipal engineers and local authorities. We must not forget that gas, when let into the air, has impurities which are poisonous. Gas burnt in a bedchamber is as bad as bad water and bad smells. The chief duties of municipal engineers have been to improve sanitary matters, to remove vegetable and decaying matter from water, and by a proper system of drainage to remove all dangers from health. But the duties of a municipal engineer will not be complete until he takes in hand the electric light. This is the one point I wish to urge—that is, that the electric lamp is not the lamp of luxury. The common argument is that it is a luxury only, and that it is only the rich man who can afford to pay for it. I say the electric light is the poor man's light. If you can have the light for 8s. 4d. per annum, the benefit which a working man derives from living in a pure atmosphere, instead of in close, unhealthy, ill-ventilated rooms, makes it worth the serious consideration of our home authorities. The price of gas is going up; the price of electricity is coming down. The price of gas is going up from labour disputes and strikes; the price of electricity is coming down because we know so very much more about it. I have not said much yet about the relative cost of production of gas and the electric light. We can produce 1,000ft. of gas for 1s. 10d.; the extra 2d. is for management and collection, though I have no doubt under certain conditions gas engineers can produce it for 1s. 7d., or 1s. 4d., or even 1s. What can we produce electricity for? It so happens I have just been making exhaustive enquiries as to the cost of electricity in the production of phosphorus and copper. These are two industries where the use of the current is uniform and continuous, and the engines, dynamos, and everything working at their maximum efficiency. In electric lighting the use of the light is irregular. People will not go to bed at the same hour, or rise at the same hour, or all use the light together, so that the "load line" is variable. Where the load line is constant—and in works where copper and phosphorus is produced it is constant—you can produce your electricity for ⅓d. per unit. There is no mistake about that figure—the cost of production of a unit of electricity on a large scale, with a constant load, is one-third of a penny. What does that mean? If we take the theoretical difference between gas and electricity, it is equal to gas produced at 3d. per 1,000ft. When we have the prospect of producing electricity at one-third of a penny per unit, equivalent to gas at 3d. per thousand, it shows that a vast field of development is before us. There is one reason why gas is still ahead of electricity. It is that there is such a market in this country for residuals, the price obtained for coke and ammoniacal liquor and the other ingredients of gas works, practically reduces the price of coal to the gas manufacturer in London to 4s. 6d. per ton. We have to pay in London for Welsh coal 23s. per ton. That is why we have to pay more for electric light than for gas. When we come to Gibraltar and Malta, where I recently went to see whether it was possible to introduce the electric light, there is no market for residuals, and it required no difficulty on my part to show that it was possible to produce electricity cheaper than gas. I have endeavoured to the best of my ability to bring this matter before you as practical men, and I want you, if you agree with my conclusions, to point out to your different boards that the duty of a corporation is to look into this matter not only from a financial, but from a political as well as a sanitary point of view, and, above all, from a philanthropic point of view, and to endeavour to persuade, as I have endeavoured to persuade you, that the electric light is the light of the future, and not the light of luxury, but the poor man's lamp.

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* Address delivered before the London meeting of the Association of Municipal and County Engineers.

ELECTRIC LIGHTING BY MUNICIPAL AUTHORITIES.*

BY PROF. HENRY ROBINSON, M.I.C.E., M.I.E.E.

As this is the first occasion on which I have met this association since the council paid me the compliment of electing me an honorary member, I desire to express my high appreciation of the honour conferred on me thereby. I gladly accede to the wish expressed to me that I should bring before this meeting the subject of electric lighting especially from a municipal point of view. The supply of electricity to the community may now be regarded as one of the requirements of the day, and it is of first importance to municipal authorities to consider the expediency of preserving the supply in their own hands Many have lost the opportunity, and have allowed companies to obtain powers over their areas. Many are now deliberating upon the point or are in conflict with companies, and, as I think, the question is ripe for decision, and I hold that it is not so advantageous for these undertakings to be carried out by private enterprise, and by outside capital, as it is by capital raised on the rates, whether from a financial or public point.

When Mr. Chamberlain, as President of the Board of Trade, in 1882 was engaged in the lengthened enquiry on the subject of electric lighting (which resulted in the Act of that year), an organisation, composed chiefly of delegates of the principal municipal corporations, urged upon the Board of Trade the necessity for entrusting the supply of electricity to local authorities, in preference to companies, in order to avoid the creation of another monopoly like gas and water, and to ensure the profits of the undertaking being secured to the ratepayers instead of to outside companies. A prominent part was taken in the action at that time by Mr. T. Eccleston Gibb (the vestry clerk of St. Pancras), whose judgment and experience in affairs relating to municipal government is probably second to none in the kingdom. He held the strong opinion that the authority should keep the powers in their own hands and Dr. Hopkinson, F.R.S., and myself were consulted at that time with a view to this policy being pursued in the St. Pancras district. The result was that a provisional order was obtained in 1883, by which all the companies were and have been ever since excluded from this district, and in this respect St. Pancras has been an exception to the rest of the metropolis in having acquired these powers. The onerous conditions imposed on companies by the Act of 1882, together with the failure of the most prominent companies to realise the anticipations that had been held out by them, led to a period of suspense which was beneficial, inasmuch as during that interval many technical and practical difficulties were overcome as regards the production and supply of electrical energy. In the year 1888 an amending Act was passed, under which many of the onerous conditions were removed, and by which the monopoly acquired by any company was extended to 42 years. By this time numerous able and enterprising inventors had been devoting themselves to perfecting the machinery for producing the supply of electricity, and of the methods of distributing it. During these years the Patent Office presents a record of inventions probably unique in the history of that department, and whatever opinion may be held as to who should undertake the work, the thanks of the community are undoubtedly due to those who served as pioneers. The time had then arrived when (as I stated to the St. Pancras Vestry in March, 1889) a public body need no longer hesitate to engage in the business, and from the points of view of finance and general convenience it was most desirable for the business to be undertaken by the authority. As regards finance, the authority can provide the necessary capital at a far lower rate than a company can, and as regards convenience, the public lighting of the streets, the disturbance of roads, and the sanitary advantages of substituting electric light for gas in dwellings, point to their being matters that clearly devolve on the authority to deal with. The wide field that is open for the employment of electrical energy for motive power, tractive, and public lighting purposes, is also a further reason for the supply being in the hands of the authority.

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* Paper read before the London meeting of the Association of Municipal and County Engineers.

I think it will be useful to put on record in your *Proceedings* calculations that I have made of the relative cost of gas and electricity which have appeared in various reports of mine, when advised on the subject of electric lighting.

TABLE SHOWING COST OF GAS LIGHTING.

Description of burner.	Candle-power.	Consumption of gas per hour per lamp.	Candle-power per cubic foot used per hour.	Cost per hour with gas at 2s. 9d. per 1,000 cub. ft.	
				Per lamp.	Per c.p.
		Cubic ft.		Pence.	Pence.
Ordinary bats-wing	10	4·3	2⅓	·142	·0142
Flat flame { from	11·5	4·6	2½	·152	·0132
Flat flame { to ...	13·8	4·6	3	·152	·0110
Flat flames in clusters	60	15	4	·495	·0083
	90	20	4½	·66	·0073
	150	30	5	·99	·0066
Special form (requiring motive power)	120	10	12	·33	·0028

On an average it may be assumed that each private lamp in London will be used for 1½ to 2 hours per day throughout the year, whilst in the suburbs it will be used 1 to 1½ hours per day. In shops open till nine o'clock, each lamp will be used three hours per day, and for public-houses, restaurants, etc., each lamp will be used four to five hours per day throughout the year.

The annual cost of gas would thus be in a private house with 30 lights used on an average 1½ hours a day, or 547 hours per annum :

	£	s.	d.
547 × 30 = 16,410 lamp hours at ·152d.............. =	10	7	11
Add for rent of meter..	0	14	0
Annual cost	£11	1	11

The cost of gas-piping and ordinary (not ornamental) fittings may be taken as follows :

Workshops and factories	20s. to 25s. per light.
Shops	25s. to 35s. ,,
Private houses (with 20 to 40 lights)	30s. to 40s. ,,

It has been feared that gas properties will be injuriously affected by the general introduction of electric lighting, and that feeling has influenced some municipal authorities who own the gas works either to oppose electric lighting orders or to secure them with a view to their not being acted on. I think the apprehension of gas properties being injured is exaggerated. There is an increasing demand for gas for warming, for cooking, for motive power, and for other purposes, which makes it quite possible that the consumption of gas in the future may not be so diminished as is feared.

I will next give the result of my calculations and experience as to the cost of electricity. In a private house with 30 lights used on an average 1½ hours a day, or 547 hours per annum, the total lamp hours will be 16,410 per annum as before.

In order to compare with the estimate for gas previously given, a 12½ c.p. may be taken as the average for each lamp (some being 10 and the others 16 c.p.).

The actual cost of producing a Board of Trade unit of electricity may be taken at about 2½d., excluding the provision for the sinking fund, or 3½d. per unit including that provision. At the rate of 3½d. per unit the cost would be as follows :

·0135 × 12½ = ·169d. per lamp hour, including renewals.

	£	s.	d.
16,410 lamp hours at ·169d.	11	11	1
Add for rent of meter	0	14	0
Total	£12	5	1

If the current is charged at 6d. per unit (which is lower than most companies charge, and will yield a profit to the authority) the cost per candle-power per hour will be about ·022d. per lamp hour, or 0·275d. including renewals, in which latter case the cost of the 12-c.p. lamp would be £19. 10s. per annum, instead of £12. 5s. 1d.

For workshops and factories the cost of ordinary fittings for electric light will be from 25s. to 30s. per lamp.

Shops.....	30s. to 40s. per lamp.
Private houses (with 20 to 40 lights)	35s. to 45s. ,,

There are several advantages in employing electricity instead of gas to which it is difficult to assign a money value. For instance, the whitewashing, painting, and papering of rooms would be seldom necessary when electric lighting is employed. The vitiation of the air by gas would be obviated, with good sanitary results, and the risks of fire would be diminished. In comparing the respective cost of gas and electricity the lamp hours are calculated as the same in both, whereas I think it will be found to be less with electric lights, as a light or series of lights are switched on and off so easily that it is found the light is more frequently turned off when it is not wanted than is the case with gas. Where delicate textile fabrics and decorative or artistic goods are exposed, it is found that the substitution of electric light for gas is attended with great advantage as regards their preservation, and also in enabling colours to be matched. Electric light is preferred to gas where wines, beer, etc., are stored, as it preserves the cellars and vaults cool.

I will next deal with public lighting, which concerns municipal authorities very closely.

For street lighting the arc light is the most economical. The smallest size of arc lamp at present manufactured requires a current of about five amperes, but for steadiness and efficiency it is desirable not to use less than six amperes. The candle-power of arc lamps varies considerably according to the angle at which it is measured. The greatest intensity with continuous-current lamps is found at an angle of about 40deg. below the horizontal line. The following table gives the approximate candle-power at various angles. The height of the lamps should be arranged so as to give an angle of not less than 7deg. to the most distant point which it is intended to serve.

LIGHTING POWER OF ARC LAMPS.

Current in amperes.	Horizontal	At angle of 7deg.	At angle of 10deg.	At angle of 20deg.	Maximum at angle of 40deg.
	c.p.	c.p.	c.p.	c.p.	c.p.
6	92	175	207	322	460
8	156	300	350	546	780
10	220	420	495	770	1,100

The following table gives the cost of working arc lamps :

Current in amperes	Average candle-power at angle of 20deg.	Watts required	Units used per hour.	Cost of current at 3½d. per unit.	Cost of carbons ·50 and fixing ·16	Total cost per lamp hour.	Cost per average candle-power per hour
				Pence.	Pence.	Pence.	Pence.
6	322	300	0·3	1·05	0·66	1·71	·00531
8	546	400	0·4	1·40	0·66	2·06	·00377
10	770	500	0·5	1·75	0·66	4·21	·00313

The last column in the table gives the cost per candle-power per hour, and these figures are arrived at by dividing the "total cost per lamp hour" by the figures representing candle-powers "at an angle of 20deg." (given in the table of lighting power) which represents a fair average of the power from arc lamps. The last column in the table of cost admits of comparison with the last column of the table previously given of the cost of gas.

Arc lights should be placed high up for the following reasons :

1. On account of their high candle-power and great distance apart.
2. Because the light thrown down at an angle is much greater than that cast horizontally.
3. Because the light given horizontally is not so steady as that which is thrown down at an angle.

The following data enable the coefficient of minimum lighting power in streets to be determined:

Let P = candle-power of lamps.
L = maximum distance from lamp in feet.
H = height of lamp in feet.
X = a coefficient.

The light falling on a unit area of pavement varies inversely as the square of the distance from the lamp, and is directly proportional to the angle at which it falls. This angle is nearly proportional to the height of the lamp divided by the distance. Therefore,

$$X = \frac{P}{L^2} \times \frac{H}{L}$$

or

$$X = \frac{PH}{L^3}.$$

The usual standard of gas lighting is represented by the amount of light falling on a unit area of pavement 50ft. away from a 12-c.p. gas lamp 9ft. high, which gives a coefficient as follows:

$$X = \frac{12 \times 9}{50^3} = \cdot000864.$$

Adopting the above coefficient, I calculate that the before-mentioned sizes of arc lights will give the same standard of light at the heights and distances stated in Table A.

TABLE A.

Current in amperes.	Height of lamps. 20ft.	25ft.	30ft.	35ft.
	Maximum distances served from lamp in feet.			
6	160	175	190	202
8	185	202	220	235
10	205	225	243	260

Table B gives the corresponding distances, assuming the minimum standard to be doubled, thus bringing the coefficient up to ·001728, which represents the amount of light on a unit area 50ft. away from a 24-c.p. lamp 9ft. high.

TABLE B.

Current in amperes.	Height of lamps. 20ft.	25ft.	30ft.	35ft.
6	130	144	155	166
8	150	165	180	193
10	170	190	205	220

The distances the lamps are apart would, of course, be double the distances mentioned in Tables A and B.

One arc lamp will take the place of from three to six gas lamps, according to the locality, arrangement, and standard of light adopted.

A scheme of arc lighting, based on the substitution of one arc light on the average for 3½ to 4 gas lamps, would double the minimum standard of light, whilst the average standard would be increased 10 or 12 times.

Placing lamps along the middle of the streets has the advantage of illuminating the fronts of the houses more uniformly, and this advantage is more apparent when the lamps are of higher candle-power than that of the present gas lamps. Moreover, in business thoroughfares the footways are often fairly illuminated by the shoplights, whereas the middle of the road is thrown more into shadow.

The regulation of traffic in crowded thoroughfares would be much assisted by a well-considered system of large lights and shelters or refuges, and the cost of police control over traffic in streets likely to become congested would be reduced thereby, whilst the number of accidents would diminish.

A higher standard of street lighting appears to be inevitable in the near future, even if it is attended with increased cost. This is evidenced by the fact that authorities are now directing their attention to affording a much larger amount of light in main thoroughfares than has heretofore been accepted as sufficient.

In carrying out a system of public lighting by electricity, the fact that the lights can be instantaneously switched on and off at a central station may be taken into account. By having a second main and by connecting the lamps alternately to the two mains, every alternate light could be switched off at, say, midnight, and a saving effected in the annual cost. It should be noticed that with public gas lamps an appreciable time is taken up in the operation of lighting and extinguishing, by which the lamps that are first lighted and last extinguished have been consuming gas beyond the actual time that is needed for lighting purposes. A series of electric lights, on the other hand, admit of being switched on and off at the central station at the exact time required by the season, so that practically the number of lamp hours in the case of electric lights is less than with gas lights to the extent of several hundred lamp hours per annum.

It is not within the province of this paper to refer to the various methods for generating and distributing electricity. Municipal authorities have abundant practical data to enable them to be advised as to the introduction of the right system for electric supply in a district. This requires good judgment and a careful consideration of present requirements, having in view the possibility of future developments.

THE ELECTRIC LIGHTING OF PUBLIC BUILDINGS; WITH SPECIAL REFERENCE TO THE ATHENÆUM ELECTRIC LIGHT INSTALLATION.*

BY PROF. JAMIESON, M.INST.C.E., F.R.S.E.

Prof. Jamieson said that he would like to explain, by aid of sketches, etc., on the blackboard, how the various efficiencies given in Table IV. had been obtained.

1. *The electrical efficiency* of each dynamo was ascertained by running it at the normal speed (500 revolutions per minute), and noting simultaneously from the ammeter and the voltmeter the amperes, C_e, in the external circuit, and the potential difference, or external E.M.F., E_e, with a constant load.

The product of these two quantities, viz., $C_e \times E_e$ = output in watts.

Having worked the dynamo at this output until the temperature of the various parts become constant, it was stopped, and the copper resistance of the armature between the brushes, R_a, the shunt magnet coils, R_s, and the main magnet coils, R_m, were taken *immediately* by a Wheatstone bridge and a Thomson deadbeat mirror galvanometer. From these resistances and the above values, the current that had been flowing in the armature, C_a, and the total E.M.F. generated in the same, E_a, when the machine was working, were calculated as shown in the paper.

The product of these two quantities, $C_a \times E_a$ = total watts generated.

$$\text{Hence, electrical efficiency} = \frac{C_e \times E_e}{C_a \times E_a} = \frac{140 \times 113}{144{\cdot}2 \times 121{\cdot}36} = \cdot904, \text{ or}$$

90·4 per cent. at *full* load for dynamos Nos. 2 and 4. As stated, the efficiency of these two dynamos rises to 91·5 per cent. at about two-thirds of full load, because then the temperatures, and consequently the resistances, of the armature and field magnet coils are not so great, or a less percentage of the total watts generated is transformed into heat at that output than at the maximum for which the machines were designed. The mean efficiency of the four dynamos at two-thirds load was thus found to be 88·5 per cent.

2. *The commercial efficiency* in the case of the Athenæum dynamos is also given as being equal to 88·5 per cent.; whereas, under ordinary circumstances, it should be less than the electrical efficiency. The brake horse-power was, however, taken with one engine coupled to its two dynamo armatures, but with the brushes lifted. Consequently, we could not eliminate the power required to drive the armatures *alone* at the normal speed of 500 revolutions per minute.

3. *The mechanical efficiency* of the engines was obtained by comparing the ratio of the brake horse-power to the sum of the indicated horse-powers of the three cylinders of the triple expansion engines when run at normal speed and load. The Crosby indicator was used for taking the diagrams.

4. *The commercial efficiency* of one engine and its two attached dynamos was found by multiplying cases 1 and 3, or 88·5 per cent. × 80 per cent. = 70·8 per cent.; because, owing to an accident to the indicator gear, we did not get a complete set of cards whilst measuring the electrical horse-power at the Athenæum by the ammeters and voltmeter. The simultaneous readings for electrical and indicated horse-powers of the new compound engines with the present dynamos will, however, be carefully ascertained when the engines have been fitted, and the results communicated to this institution.

5. *The theoretical efficiency of the engine.* This was ascertained by calculation from the indicated horse-power and the weight of steam used per indicated horse-power at known pressure and temperature.

6. *The commercial efficiency of the boilers.* This value was not ascertained, because it would have entailed not only a chemical analysis of the flue gases, but also their weight and temperature. The term commercial efficiency is used in different senses by different engineers. We, however, prefer to keep the term "commercial" for the ratio of the energy got out to the energy put in.

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* Discussion on paper read before the Institution of Engineers and Shipbuilders in Scotland, *vide E.E.*, May 1, 8, 22, 1891.

and hence we have stated the "commercial efficiency of a boiler" to be the

$$\frac{\text{Heat units in steam generated from every pound of coal burned*}}{\text{Available heat units from every pound of coal burned}}.$$

This is an important quantity to be ascertained by the engineer, since it tells him the efficiency of a boiler as a means of transferring heat from the heated surfaces to the water.

7. *The theoretical efficiency of the boilers.* This quantity was ascertained in the following manner:

Steam at 145lb. absolute = 355deg. F., and absorbs 1,190 B.T.U. per pound when raised from water at 32deg. F.

But the feed-water was 145deg. F.; ∴ 145deg. - 32deg. = 113 deg. F.

Or, every pound of water had received 113 B.T.U before being introduced to the boilers.

∴ 1,190 B.T.U. - 113 B.T.U. = 1,077 B.T.U. *per pound* from water at 145deg. F. into steam at 355deg. F.

The coal used was only capable of converting 12·5lb. water at 212deg. F. into steam of 212deg. F., thereby absorbing 966 B.T.U. I arrived at this result from tests of the samples of the coal used by Thomson's calorimeter (as described at page 39 in Jamieson's "Text-book on Steam and Steam Engines," fifth edition).

But in the Athenæum boilers 6·8lb. of water were converted into steam at 145lb. absolute, by the combustion of each pound of coal.

Consequently, how many pounds of water would have been converted into steam from and at 212deg. F.?

$$966\text{ B.T.U.} : 1{,}077\text{ B.T.U} :: 6{\cdot}8\text{lb.} : x\text{ pounds.}$$
$$\therefore x = 7{\cdot}58\text{lb.}$$

From the above we can now deduce the efficiency of the boiler; for

$$12{\cdot}5\text{lb.} : 7{\cdot}58\text{lb.} :: 100 : y.$$
$$\therefore y = 60{\cdot}6\text{ per cent.}$$

$$\text{Or, } \frac{\text{Heat units in steam generated per pound of coal}}{\text{Total heat units per pound of coal with perfect combustion}}$$
$$= \frac{7{\cdot}58}{12{\cdot}5} = {\cdot}606 = 60{\cdot}6\text{ per cent.}$$

8. *Theoretical efficiency of the whole plant.*

Regarding the theoretical efficiency of the whole plant, see Table IV. We may check the result as follows:

Theoretical efficiency of boiler (60·6 per cent.) × theoretical efficiency of steam in the engines (7 per cent.) × the commercial efficiency of engines and dynamos (70·8 per cent.) = 3 per cent.

The **President** said they had heard Prof. Jamieson's explanatory remarks, and he now called for any further criticism.

Mr. Thom said he would confine himself to the mechanical arrangements. The author stated that, "Where the space is unlimited, then undoubtedly a slow-speed compound condensing engine of the Corliss or other quick and early cut-off type is to be preferred. Their efficiency is higher than that of any other class of engine." This was an assertion which must not be allowed to pass uncontradicted, as this antiquated theory of slow speed and early cut-off had done more than anything he knew to retard the advancement of the modern steam engine. The only point which could be claimed in its favour was the appearance of the indicator diagrams which had more beautiful expansion curves, and were therefore more suitable for showing the action of the steam in a cylinder theoretically. In practice the most economical engine was the quick-running compound or triple expansion, carrying the steam over half stroke which gave less condensation in the cylinders. As theory always followed hard on the best practice, he had turned up the last book on the subject by Prof. Cotterill, and had found it stated "that low-speed engines are less economical than high will be readily admitted," the reverse of which the author stated, and he pointed out that the condensation varied inversely as the square root of the revolutions, but they did not require to decide this question from a theoretical standpoint. The Admiralty found the engines so wasteful when working slow with an early cut-off that, when practical, they arranged two sets of engines on one shaft and only worked the one set when working at half power. He found from looking at the drawing of the boiler and connections that the arrangement had not had the consideration it deserved. Great care had been bestowed on making duplicate sets of pipes, but the part most likely to give trouble was common to both boilers, and instead of care being taken to save that part from fracture, there was stress put on it which it never was intended to take. He spoke of the connections between the steam receiver and the boilers. It would be noticed this was a rigid connection, but when steam was in the receiver it would lengthen, owing to the higher temperature about a quarter of an inch between the connections to the boilers. This had not been taken into account, so it was only a matter of time before the expansion and the contraction of the receiver broke this connection. He might say this arrangement would not be passed by the Board of Trade or Lloyd's surveyors. The receiver should be in halves, or connected to the boilers by flexible copper pipe, with bend or other arrangement of joint which would allow for expansion. He saw no reason why lives should not be guarded from obvious danger on land as well as at sea, and hoped to hear that this dangerous connection would be made safe for the attendants and others.

Prof. Jamieson: When I said "slow," I did not mean slow piston speed, but few number of revolutions per minute. I would keep high piston speed, but a good long stroke. First, in regard to the early cut-off engines, I may say as a matter of careful experiment that Mr. Ferranti, with small Corliss condensing engines at Deptford, obtained 13·5lb. of steam per hour per indicated horse-power. I know of no triple expansion engine that will beat that.

Mr. Thom: The triple expansion engines of s.s. "Iona," recently tested under ordinary working conditions by Prof. Kennedy and scientific staff, were found to use 13·35lb. per indicated horse-power per hour.

Prof. Jamieson said his experience had been that, given unlimited room and money, they were better off, taking everything into consideration (economy, freedom from breakdown, and expenses of upkeep), in the particular case of electric lighting, with simple, steam-jacketed, strong horizontal engines running at about 100 revolutions per minute, with a fair piston speed of, say, 400ft. per minute, having small clearance spaces and an early cut-off, than with *very* short-stroke high-speed engines, whether of the simple or compound type. More especially was this the case when they were far removed from the maker's works, and desired to employ an ordinary engineman instead of a highly-paid skilled mechanic. He had proved this to be the case in several instances. In regard to Mr. Thom's objections to the connections between the boilers and the steam dome, he had only to say that they had received due consideration from several points of view. Freedom faucet joints were employed, and, in addition, the stools upon which the boilers rested were made to a larger radius than the outside of the boilers, together with expansion hole in front smoke-box, so as to permit of free movement due to expansion or contraction of the steam dome. The original tender drawings, as well as the boilers, had been duly inspected and passed by the Boiler Insurance Company, of which Mr. Longridge, of Manchester, was the chief engineer.

Mr. Mavor: I think the institution owes its thanks to Prof. Jamieson for bringing this paper before it, but the paper as it stands is most disappointing and unsatisfactory, except when supplemented by the information which he gave this evening, and details of the boiler tests, which, we hope, he will be induced to produce. The question of high and low speed depends upon the size of the engine which you have to deal with. With a small engine, there is no doubt that the high speed is more economical than the low speed. The experience he spoke from was very accurate tests of different types of engines.

The **President**: I think it would clear the mind of many members present if you would speak of engines with high revolutions as compared with low revolutions. The engineering mind does not distinguish between engines with a great many revolutions and engines with fewer revolutions. It is the speed of the piston that we speak of when we refer to the speed of engines.

Mr. Mavor said the state of matters was something like this, that where they had small machines they wanted to get an efficiency and the revolution as high as possible, and that tended to high revolutions to begin with. By using the engine coupled with the dynamo, they eliminated the trouble that was likely to arise from any gear whatever. That, he thought, there could be no dispute about, that an electrician in choosing a dynamo would choose an engine with high revolutions. When Prof. Jamieson said, "As the lamps get older, the carbon loops get thinner, and consequently their resistance increases, therefore we have to gradually increase the pressure to 115 volts as circumstances require," that method of procedure was utterly fatal to economical working. The condition of affairs in various instances might slightly modify the evil which this procedure brought about, but it would be evident that if the lamps began to increase in resistance and the pressure was increased accordingly, whenever they introduced new lamps, which were more valuable than old ones, intended to run at 110 volts, and they put in a pressure of 115 volts, it was proximate ruination. Of course the difficulty then arose that the lamps decreased in brilliancy, and the cure was to remove them as they increased in resistance, and replace them by new ones even before they broke down. It was just possible to get out of a lamp the life of 1,500 hours, but probably a life of 1,200 to 1,500 hours was a pretty economical one, especially as the cost in a year or two would be less. It was perfectly fatal to get the brilliancy out of old lamps. That was one important point. Then a statement was made to this effect: "A fair comparison has been made between the price that would be charged by any outside central lighting station at 8d. per B.T.U., and the actual cost to the Athenæum for generating the same by its own plant. It will thus be seen that for public institutions, etc., where there is a sufficient demand for light, a very considerable saving may be effected by running a private installation." Such calculations were extremely difficult to make without, at least, 12 months' experience of running. He found that Prof. Jamieson had got all the items in this calculation, and he had said that he had no objection to publish them in the *Transactions*, which would be found interesting. He might mention that while the cost in the Athenæum was 4·06d. per B.T.U. on a certain day in March for generating electricity, that was not by any means an unusual economy for such a load, and they had found frequently that they could reduce the cost in the following ratios. If they took a long day in winter, it would be found that the number of units generated brought down the cost to a very low point, in some cases as low as 2d. per unit, whereas in small runs it rose up to 11d. or 1s. Therefore, to take a single day was no guide to economy. The putting down of a lighting station was a most important one. It would be better for electric lighting if everyone had his own electrical manager, but he was very strongly of opinion—

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* Just as it is customary to call the "commercial efficiency" of a dynamo

$$= \frac{\text{the electrical horse-power got out}}{\text{the brake horse-power put in}}.$$

and to his own loss he had held the opinion—that it was a great mistake for anyone in the centre of Glasgow to put down an electrical station with one or two exceptions. The only exceptions were the newspaper offices, where they would manufacture electric light cheaper than gas, and the railway stations and hotels, where the demand for light existed all day, and coal was obtained cheaper at these places. They could make it for 3½d. per unit. Mr. Preece, of the London Post Office, claimed to do it for 3¼d. With such a case as the Athenæum, he was satisfied that, leaving out of consideration the enormous labour entailed in superintending the installation, and having an engineering manager in their place, the cost was out of all proportion to the advantage gained by so doing. There were one or two points of the general arrangement that he would like to call attention to. The drawing of the supply curve was very interesting, and the author said that it would show as favourably as any building that was not used during the night for putting in its own plant. At the same time, giving it the benefit of all that apparent advantage, he was quite satisfied that they would be much more comfortable and happy if they sold off their plant as soon as the town was able to supply them, and not increase it any further. Then with regard to the switchboard, it was a little difficult to follow it, but Prof. Jamieson was good enough to give him an explanation of it that day. There was the connecting switch. The purpose for which this switch was inserted was to prevent the dynamos from reversing on each other. It was his opinion, and open to discussion, that in such a case these machines ought not to be compound ones at all. They had in many cases compound dynamos for running parallel, and there was no object in having them parallel, because they required so much attention. Although a good deal had been said about compound winding, it seemed disadvantageous to divide the dynamos into four. One could not see the object of that, because with two properly constructed dynamos and one spare armature with a set of batteries the arrangement would be much simpler.

Mr. Couper said he was sorry that Prof. Jamieson did not give in his paper all the data which he had given since. The paper was a little difficult to discuss on that account, but there were one or two points he should like to take notice of. Under the heading, "General Arrangement of Plant," Prof. Jamieson said: "In installations of moderate dimensions, such as we have been considering, where space is of great moment, the engines, boilers, dynamos, etc., may be all placed with advantage in one room." He was inclined to think that such was not a good arrangement, and was one neither to be commended nor followed. In the Athenæum the engines and dynamos were placed close to the boilers and entirely unprotected, so that it was impossible to prevent the dust from the coal and ashes lodging on those very parts which should be protected, and kept free from grit. Everyone knew the amount of dust that gathered in a place where boilers were being fired, and if no other arrangement could have been made, surely a glass and wood partition could have been put up, shutting off the dynamos, engines, and switchboard from the rest of the space containing the boilers. It was all very well at first with a new start, but how about the tear and wear, and the renewal in course of time? As to the type of boilers used, he believed it was the one best suited for that and many other purposes. He just noticed the other day the report of a paper read on April 7 by Mr. R. E. Crompton before the Institution of Civil Engineers, in which the author stated that the space from front to back in electric light stations was generally so limited that boilers of short length and easily transported, and built in position, were best suited for this work. The boiler which occupied the least cubic space, and yet fulfilled the other requirements, was the one best adapted for situations like that of this installation. Space was limited, and generally so; it was a rare thing nowadays to find a public building where space was no object. The type his firm had supplied to the Athenæum was one that was easily accessible, and had its external surface visible at all times; it was not surrounded by brickwork, beneath which corrosion might be going on unknown. In regard to the receiver, to which one gentleman had taken exception, he might say they did not approve of its present arrangement. They suggested a connection by a copper bend pipe from each boiler, but Prof. Jamieson, as the consulting engineer, preferred a rigid connection, and went into the question of expansion to see what the amount would be, and satisfied himself with the arrangement. He also told them that he got the sanction of Mr. Longridge, and ultimately the connection was made as it then existed. So far, it had not given any trouble that he knew of.

Mr. Lindsay Burnet said that with regard to the mechanical engineering part of the paper, he would remark that it was generally found that the space was limited in public buildings, therefore, the slow-working flue boiler, having suitable heat-absorbing surface, was rather out of the question at ordinary working pressures, and to his mind would be entirely out of consideration for a pressure of 150lb. per square inch, such as was used in the present instance. Naturally, a slow-working machine was more easily tended than a fast-working one; but he ventured to think that with the great variations of power required in cases like this, the fast-working boiler, along with the higher intelligence of the attendants, would attain the highest commercial efficiency. One would have expected that a well known public teacher like Mr. Jamieson would have treated this part of the subject in more exact language than to speak of horse-power of boilers without defining that horse-power in some way. The Athenæum boilers might be 60 of that unknown quantity, if you coaled them to that extent; but from Table IV. at that output, the heat efficiency was only 58·6 per cent. Of course it might be (for the paper gave one no means of judging) that that low heat efficiency satisfied the whole calculation for real commercial efficiency as referred to the Athenæum. But he was prepared to say that for a steam plant working only nine hours' full power out of the 24, it was best to attain to 70 per cent., irrespective of the first cost, so as to give the highest commercial efficiency. Regarding this low heat efficiency of 58·6 per cent., he would like to state that with the grate area as used at the trial, which was as much as one-sixteenth of the total heating surface, it would require great skill to prevent waste of fuel, and it would here be interesting to know if the forced draught appliance was in use at the time. In the face of this, when it was remembered that boiler efficiency, as usually stated, was a combination of the efficiencies of the firemen, of the heating surface, and of the furnaces, as well as of the fuel used, it was just possible that the efficiency of transmission through the given heating surface was really good; and, of course, this was the point for the boiler engineer when he had not a free hand for the whole arrangement. In Table IV., Mr. Jamieson gave, in item No. 6, a statement (without the value attached) of commercial efficiency which he (Mr. Burnet) considered quite misleading, and really useless to the steam user. It would be of great interest here to know how a value was arrived at by Mr. Jamieson in making up his complete statement of cost of light to the Athenæum proprietors, as compared to equal light brought from a central station. In the paragraph headed "Pipes and Flues," the statement was made that "throttled passages check the flow of these fluids (steam, water, or gases) in a most decided manner." The reason why this well-known truth had impressed the consulting engineer of the Athenæum so much as it seemed to have done, was that he decided at first to connect the original small chimney by a wrought-iron box flue to the new boilers, the result being that there was not sufficient draught to burn the fuel, and hence the blackest of black smoke, and little steam. A steam jet forced draught appliance was got and did no good; only at last was a proper chimney erected, which appeared to give such excellent natural draught that most practical men would wonder of what use was the steam jet. Let the grate surface be made so that 20lb. of good coal be burned with natural draught per square foot of fire grate, get an intelligent fireman who would regulate the fire with the chimney damper and not by the fire-doors, as was mostly done at present; there would then be abundance of steam with economy, and no more smoke than at present. With reference to Mr. Jamieson's remarks on the engines, he would say of them much as he had said in regard to the boilers as concerned size and speed; and also that he had it from engineers of experience in such matters, that commercial efficiency was attained best with subdivided power, just as adopted in the Athenæum. Undoubtedly it required men of higher intelligence to tend fast-steaming boilers and fast-running engines, and one could not (to take an extreme instance), expect a farm labourer who now and again shoveled coal below an egg-ended boiler, to be able at once to keep steady steam in a fire engine boiler, or in a Thorneycroft tubular torpedo boat boiler. Nevertheless, the higher intelligence could be procured, and should be got and paid for, as it could easily be out of the saving effected.

Mr. M'Whirter said he was surprised at seeing Prof. Jamieson publishing such statements at they had in that paper. The information Prof. Jamieson had given rather cleared the ground; but it would have been much easier and much better for the discussion if the facts and figures put forward that evening had been embodied in the paper as published; particulars of tests were always more valuable than the results. Results were always suspicious. This with all respect to Prof. Jamieson's standing, as he was sure that the author would be the very last to accept results from anyone without the necessary data enabling these to be discussed. He (Mr. M'Whirter) wished to call attention to the factors of efficiency. He quite agreed with the position the author took up in regard to the difference between small high-speed engines and larger engines running with slower revolutions. In the Athenæum it would have been impossible to have put in large Corliss engines, which would no doubt have given good work and high efficiency. When it was remembered that such engines as those turned out by Willans, running at 400 revolutions, and obtaining an electrical horse-power for something like 18lb. of steam pressure—

Prof. Jamieson: More than that—28. An electrical horse-power would require fully more than 28lb. of feed-water per hour.

Mr. M'Whirter: If Prof. Jamieson would refer to the discussion last year at the Institution of Electrical Engineers, he would find it as he had stated. He referred to the discussion on Prof. Forbes's paper on electric lighting, etc. Here Prof. Forbes referred to one firm in Berlin using Corliss engines, and working with a consumpt of 15lb. of water per electrical horse-power. It would be a very good thing if they were to get the results of the forced draught that Prof. Jamieson had used. This was something new, and it would be a very good thing to get the steam results with and without it. From the author's remarks about the accumulators, and the defect of avoiding reversals, it appeared that he had no E.M.F. cut-out in use.

Prof. Jamieson: We have that. It will be seen in the drawing.

Mr. M'Whirter: Coming to the dynamos, he did not at all agree with the remarks of Mr. Mavor. He had no trouble whatever in using compound dynamos, either in working them singly or coupled together; but at the same time it was necessary to assist the regulation of compounding by means of a small rheostat inserted in the shunt circuit; the reason for this, which was well known, being that, no matter how exact a dynamo might be made to compound immediately on starting work, the rise of temperature in the field magnet coils altered the relative values of the shunt and series excitation, and lowered the permeability of the field magnets. As the temperature increased, both tended to reduce the voltage at the terminals of the machine after having been run for some time. In using compound dynamos on the same circuit where accumulators were used, they were certainly troublesome, but this could be easily guarded against. His firm used an arrangement whereby it was quite impossible to have the accumulators joined up to the main circuit at the same time as the dynamos. It was exceedingly simple and convenient. It was a pity the sizes upon dynamos were not marked, as the smallness of the scale made accurate measurements difficult. The first thing that would occur to electrical engineers was that the Athenæum dynamos appeared to be much too small for their work. He did not understand why such small machines were put in, and this impression was confirmed by the electrical data. Taking the revolutions as given, also the volts and the armature-turns, using Kapp's formula, then

$$K\,L = \frac{115}{500 \times 24{,}810^{-6}} = 1{,}200$$

useful lines in the magnet, and taking the magnet as 10in. diameter, then there would be 78·5 square inches, or a flux per square inch

$$= \frac{1{,}200}{78{\cdot}5} = 15{\cdot}3\,;$$

or, taking the leakage value as equal to 1·35 for this form of field, then the total flux per square inch = 20·7. This was not only much above usual practice, but was higher than what has hitherto been taken as the theoretical limit of magnetisation, and showed that the watts expended in obtaining this very intense field were much too high; in other words, that the magnetisation was obtained at too high a price. This would be seen when they considered that the force required for magnetisation had to be increased from 4·6, with an induction of 16 lines per square inch, to 7·7, with an induction equal to 17 lines per square inch. Modern practice showed that very few dynamos were now made with a greater magnetic flux than 10 lines per square inch (useful). He (Mr. M'Whirter) had occasion to design a dynamo for almost exactly similar output. Instead of having 78·5in. of cross-section in the magnet, he had found that to get good work it was necessary to put in section equal to 117 square inches, and this dynamo had a drum armature, whereas the Athenæum machines were Gramme wound. Coming to the armature of the Athenæum dynamos, he found them in much the same condition as the field magnets—namely, overloaded. The armature-turns were given as 248, and this multiplied by half the total current gave the load in ampere-turns:

$$248 \times 77 = 1{,}900 = \text{ampere-turns.}$$

(*To be continued.*)

CAMBRIDGE LIGHTING.

At a recent meeting of the Town Council, the debate on electric lighting was resumed.

A comprehensive report from the Electric Lighting Committee was placed in the hands of members of the Council, giving the entire history of the work of the committee since their first meeting on November 15, 1889. The proceedings included Dr. Fleming's report, which was before the committee on the 11th December, 1889; the arrangements made by the committee as to the employment and remuneration of Dr. Fleming; Dr. Fleming's reports of the 9th December, 1890, and 14th April last; and, lastly, the letters from Prof. Garnett to Mr. Finch, dated 14th April, 20th April, 25th April, 28th April, and 12th May last. These had reference to the system of electric lighting which has been carried out by Mr. Parsons in Newcastle-upon-Tyne, and which Prof. Garnett believed to be well adapted to the requirements of Cambridge. The letters also gave the results of the tests applied to Mr. Parsons's radial generator, with a view to arriving at the coal consumption. The committee presented all these documents for the consideration of the Council, and again recommended the adoption of the report of the 1st of May last.

Alderman Finch said the main question they had to consider that day was not whether the Council would adopt a system of electric lighting for public streets, because that question had been raised and distinctly decided on a former occasion, but what system they were prepared to proceed with? He would not ask the Council to definitely order the committee to adopt the system which was then under consideration, but he would put it in another shape, and ask them to authorise the committee to carry the scheme out. The committee came before the Council that day asking for authority. Surely it was high time, now that that question had been before the Council for so long a time, to take some definite steps. It was very desirable, as he said on Thursday last, that they should utilise the winter. If the winter was over before the electric light was established, they would not get that support from the customers which they would have if they had the light in the earlier part of the winter. He did not think he need bother the Council by going into the details of the question, because the documents which had been printed by order of the Council had been placed before the members of the Council. First of all, there was the report of the sub-committee who went to Newcastle; then they had the letters and the discussion raised by Dr. Fleming; the replies of Prof. Garnett and Mr. Parsons, and the subsequent letters of Prof. Garnett. The committee found that the works at Newcastle, where the turbine engines were in use, had been able to give a certain substantial result, and that business had been carried on at a profit. Therefore, even those engines, imperfect as they were, speaking in the light of present improvements, were satisfactory for the purposes to which they were applied. If they were satisfactory, that was to say, in regard to yielding profits, then they had one substantial fact on they could proceed with their work in Cambridge. He did not know whether the committee would, even if they were advised by the Corporation, adopt precisely the same machines that were in use at the works at Newcastle, because there was undoubtedly a great deal of difference in the price of coal at Newcastle and Cambridge, and what would very well pay at Newcastle would not necessarily pay in Cambridge. But they were shown a new form of turbine, which would effect very great economy. An experiment had been made upon the new machine, and the result went to show this: that it was more efficient than those in use at Newcastle, and it required 60 per cent. less fuel to do the same amount of work. Therefore, if they could make a profit at Newcastle, they could make a profit at Cambridge. They were not, as had been charged against the committee, taking upon themselves the duties of experts. No man sitting round those tables who was about to take up that question would say he was an expert; he would ask for certain facts, make enquiries what the outlay and revenue was likely to be, would see the different kinds of machinery in use, and the result would be that a man of business would be in a position to form a judgment as to whether he would or would not adopt a system. The committee and sub-committee had been doing something of that kind. It had been suggested that there was only one opinion amongst engineers with regard to that invention, and that opinion was adverse. He had with him one of the volumes of the *Proceedings* of the Institution of Mechanical Engineers in August and October, 1888, when Mr. Parsons read a paper describing the turbines which are now in use at Newcastle. There was one chorus of praise from beginning to end. After reading extracts from the speeches of several men of eminence in favour of the scheme, Alderman Finch said if it was true that there was only one opinion upon that matter, they then knew from an authoritative source what that opinion was. He did not think he need go any further into the merits of the scheme. The sub-committee who went to Newcastle was composed of men who were very fairly representative of the Council. They were shown figures similar to those sent to the Board of Trade as to their capital, the balance-sheets and the monthly pay-sheets, and as the Council could not go and look at those documents for themselves, they asked them to say that they would believe those men of business, and study the statements that had been made. He contended that the paragraph in the report which had been criticised by an electrical journal had been abundantly verified, inasmuch as instead of there being a gain of 35 per cent. there was a gain of nearly 50 per cent. What they asked them to do was to authorise the committee to proceed on the lines of their report. If they agreed to that, they would be asked to appoint Prof. Garnet as electrical engineer on the terms which he addressed to the town clerk, and which the committee thought very reasonable, and then they would be asked, further, to authorise the Electric Lighting Committee to proceed up to a certain amount of expenditure. He then proposed "That the committee be authorised to proceed on the lines of their report."

Councillor Scott seconded the motion.

Councillor Dr. Porter said he felt very sorry that he found it necessary to move an amendment, and make some remarks upon the report of the committee. The first point he would like to refer to was the position of Dr. Fleming, who was one of the highest authorities on electric engineering. Dr. Porter had read a copy of a letter forwarded to Dr. Fleming by the town clerk, which he said made it clear that Dr. Fleming had been appointed by the Council. He contended that the committee had no right to dismiss an officer appointed by the Council, and asked for Dr. Fleming to be reinstated as professional adviser to the Corporation. If the committee dismissed an engineer simply because he expressed opinions which did not coincide with their own, he did not see the use of an expert at all. He would like to make one or two remarks upon the report of the Electric Lighting Sub-Committee, which was adopted by the Electric Lighting Committee. The most important question for the Town Council to consider was, he thought, would the working be remunerative? Alderman Finch referred to the accounts kept at Newcastle, and mentioned the profits they might expect if that system was adopted. It seemed that the balance for the half-year was £843. Dr. Porter then referred to what he considered to be two most important omissions from the accounts—namely, interest on the capital expended and repairs and renewal of the machinery. If those items were allowed, the profits would be £65, and if they deducted a further sum for extra cost of coals they would have their profit of £843 converted into a loss of £400. He thought from that statement it was quite clear that the works at Newcastle afforded no satisfactory basis for them to work a similar system with any chance of making any profit whatsoever. He next quoted statements from the report of the sub-committee, with a view of showing that twice the amount of steam was required to work the turbine system that was necessary for working other systems with an ordinary engine, and read extracts from a letter from Messrs. Willans, objecting to misleading statements in the report as to the consumption of steam in the Parsons turbine and the Willans engine. It was stated in the report that in the new form of Parsons turbine, a saving of 35 per cent. would be effected, and Mr. Alderman Finch in his speech had advanced this saving to 50 per cent. Prof. Garnett's reports rested far too much, like that of the committee, on hypothesis. Why were not the experiments conducted on the new installation at Scotland Yard, and all hypothetical statements got rid of? He stated that an experiment conducted on the electric installation at Peterhouse, under the superintendence of the Demonstrator of the Engineering

Laboratory, showed that the consumption of coal per unit generated was 8·5lb. He thought the only justification for the Town Council undertaking any system of electric lighting was to make a profit for the relief of the rates. If they could not show clearly that they could make a profit, then it would be quite wrong for the Council to undertake a scheme which might involve the ratepayers in a great loss. He moved in substance that the report be amended, by referring the question of the efficiency of the Parsons turbine as a motor to Mr. Kennedy, M.I.C.E., and that Dr. Fleming be reappointed professional adviser to the Corporation.

Councillor Vinter: May I ask the question whether Dr. Fleming was appointed by this Council?

The **Town Clerk**: No, sir; he was not.

Councillor Vinter: Then Dr. Porter's contention entirely falls to the ground.

Councillor Dr. Porter then read a portion of the town clerk's letter to Dr. Fleming, which was as follows: "I have to inform you that the terms stated in your letter describing the scope of your duties in regard to the electric light in the town were approved by the Electric Lighting Committee, and upon their recommendation have been sanctioned by the Council, subject to a slight alteration in paragraph B."

Councillor Vinter: That, surely, is no appointment by the Council.

Alderman Cockerell seconded the amendment, mainly because he thought the matter required further consideration, and that they ought to receive further advice before they proceeded with any scheme. If they did as Alderman Finch asked them to do, they would be committing themselves irrevocably to that particular scheme. He thought the matter was one of such great importance to the town that they could not do better than have further advice before taking further proceedings in that matter. As to whether Dr. Fleming was appointed by the Council, he was surprised to hear the suggestion that he was not. He distinctly remembered the committee making a report to the Council, and the Council confirmed that report. If that was not an appointment by the Council he would like to know what was.

Councillor Vinter differed with Alderman Cockerell, and said it was not a question for further consideration at all. It was a question of the disposal of the electric light for Cambridge by the Town Council, and if the recommendation of the committee was thrown out that morning, he thought they would have a very great deal of difficulty in finding a committee who would labour for the electric light as they had done for years past. First of all, he contended that Dr. Fleming himself had practically resigned—he never was appointed by the Council at all. After that they could not place any confidence in him as a practical man. Dr. Porter laid stress upon the balance-sheet prepared at Newcastle, from which he argued that there would be a loss if the system was adopted in Cambridge. But Dr. Porter might have looked a little further, and told the case fairly. Dr. Porter assumed that the price of the electric light in Cambridge was going to be the same as in Newcastle, whereas it was going to be 25 per cent. more, which made a difference of £1,200 per annum. He thought Dr. Porter ought not to have omitted such an important fact. The reasons Prof. Garnett expressed himself in favour of the scheme were, first, the small cost of the machinery, and then he went on into details about the buildings and the efficiency of the scheme. Now, if the cost of the machine be one-third less than that recommended by Dr. Fleming, and the efficiency was the same, it could not possibly be contended that they were advocating the cheapest thing simply because it was the cheapest. He was sure that every member of the committee was perfectly satisfied that that was the best scheme. There was only one member who differed as to the report, and he not upon the principle: he thought it would be better in the hands of a company than in the hands of the Corporation. They had the unanimous report of the committee, and he hoped that they would support it. If the Council were going to undertake the work, they ought to do it at once. Their provisional order would run out next July, and they ought not to lose the chance of taking the matter up. He thought that past experience showed that if the Council had been wise in taking up the work of the water and gas companies—and he went further, and said the tramways—they would be very much better off than they were.

Councillor Burford expressed a hope that the amendment would be accepted. They had the ratepayers to study, and he maintained that they, as a corporate body, ought not to enter into any commercial speculation unless they could make it pay. They were in no particular hurry for the electric light; they could wait a little while. He thought it would be a great deal better—there would be less expense and risk—if a company took the matter up. He did not know they had individuals who could carry out that matter better than they could in London. They did not find any corporation or vestry having taken the matter up in London, and he thought that with one exception public bodies were like London. If they went to Birmingham, they found the Council in a similar position to themselves. They found, after a great deal of discussion, it would be much wiser and less expense to the ratepayers if a private company took the matter up. He felt certain that the adoption of the electric light by the Council would mean increased rates. If they borrowed £30,000 or £40,000 it must mean an increase in the rates. He felt certain that if they promoted that scheme they would have increased rates, but if they threw the responsibility on an individual or company they could get what they asked for. It was too serious a matter to enter into that scheme hastily. They had had some splendid reports, but when Dr. Fleming probed the scheme he found it to be a failure. He said that Dr. Fleming ought not to have been dismissed. Dr. Fleming was a most conscientious man, and too conscientious to allow the Corporation to be dragged into a thing which he thought would not pay. He wanted the electric light—it was a splendid thing—but he thought they ought not to spend the ratepayers' money when they would not receive benefit. He knew there was a strong feeling that it would be a good thing if the matter was in the hands of a company.

Councillor E. C. Young thought they had already settled the question some time since that they intended to carry that work out. Were they discussing that morning whether they were to have the electric light or not? He understood they had already agreed to undertake the electric light, and the only point they had to consider was, which was the best method of carrying it into execution. On the advice of Dr. Fleming, a scheme was submitted to them which they thought would pay, both financially and as far as the lighting was concerned. To their surprise they discovered, as time went on, that instead of that being the case, the initial costs were so great that the committee must of necessity stay their hand. A sub-committee was appointed to consider whether some more excellent way might not be devised for executing what was the intention of the Council. The sub-committee visited Newcastle and Bradford, and came back with a report strongly advocating the adoption of Mr. Parsons's system. They had not dismissed Dr. Fleming; he said Dr. Fleming had practically withdrawn from the situation. When the matter was submitted to Dr. Fleming, he distinctly said he could not recommend the system of Mr. Parsons; and they, on the other hand, could not accept Dr. Fleming's scheme, because the costs were so great. The question was whether they should or not adopt the system of Mr. Parsons, which, in contradistinction to Dr. Fleming, they believed could be worked at a profit. He did not expect much profit for the first year or two; no one who started a new venture expected that; but when he looked at the fact that the light would be all over the town in 10 or 15 years' time, he thought that those who found the money for the undertaking would receive profit from it. In the case of the water and gas companies, the people all over the town were obliged to have water, and in many cases they were obliged to have gas, and the shareholders reaped the benefit; but if, on the other hand, the Corporation undertook the management of those concerns, the ratepayers would have received the benefit. That was the reason why he had always advocated that those concerns should be in the hands of the Corporation.

Councillor Dr. Kenny observed that Councillor Young seemed to forget that the inhabitants of the town were under no obligation to have the electric light. Their experience had been very much enlarged in more than one direction since they first formed the idea of applying to the Local Government Board in reference to that matter. What had they there that day in that report? They had a record of the changes and experiences of the committee. It was not very long ago that a scheme was to have been carried out by Dr. Fleming. That was put to the test of experience by the opponents of the scheme and collapsed. Then the committee brought forward another scheme, which looked equally well upon paper. That was submitted to the onslaught of Dr. Fleming, and that again collapsed, and the consequence was Dr. Fleming collapsed also. He (Councillor Dr. Kenny) was contending that day that they were entitled even at that stage to consider whether or not it was desirable that the Corporation should undertake that work. Councillor Burford had told them that his increasing experience of the work of the Corporation had led him steadily to believe that it would be unwise for the Corporation to undertake extra duties. He confessed exactly the same. He was in a position of doubt when he first came into the Council, but his increasing experience of the burdens on the shoulders of the Corporation led him to think that they were not a body sufficiently numerous, and had sufficient leisure to be able to take upon their shoulders an extremely important commercial undertaking. He felt that the more because that undertaking involved a capital expenditure of not less than £27,000. That might be a fleabite to some Corporations, but they were to take it upon their shoulders when they had a great sewage scheme which they could not possibly put off. For those reasons he hoped they would pause before it was too late, and resign that important undertaking to private enterprise.

Councillor Whibley said that with reference to the question which had been raised as to whether the scheme should be undertaken by a Corporation or a private company, he felt very strongly that it should be in the hands of the Corporation.

Councillor Bond said that as electricity was comparatively a new science, and improvements took place every year, it was just possible that after the committee had been at work sometime, they would find a more excellent scheme than they had at present. He thought they were very much indebted to Dr. Porter for pointing out that they ought not to undertake works of that sort unless they would be remunerative. He (Councillor Bond) would rather say, unless the town were safe from losing money. If the committee were going to carry out that scheme, had they made up their minds that the town would not incur a loss? If they did not carry that report, of course the committee would resign. Where were they going to get another committee? He thought it would be better if a private company were allowed to carry the scheme out; but under the circumstances he had come to the conclusion that they would be able to make it pay, and the town would not be involved in a loss. He did not feel disposed after the hard work the committee had done to oppose the motion.

Alderman Finch pointed out that if he shared the anxiety shown by several members of the Council as to whether the undertaking would pay, he would not make the proposal he had done. He was confident that the scheme would be made to pay. With regard to Dr. Fleming, when he arrived at that conclusion which ad been stated, there was not a single member of the committee repared to go on with his scheme. He contended that Dr. Porter ad formed his opinion on narrow premises, and concluded by tating that the committee believed that the scheme would pay s way.

On the amendment being put to the meeting, 10 voted for it nd 19 against. The motion was then agreed to.

On the motion of **Alderman Finch**, seconded by **Councillor Vinter**, it was decided to appoint Prof. W. Garnett electrical ngineer for carrying out the scheme.

It was also decided: "That in the event of their report of 1st day being adopted by the Council, they be authorised to conclude ontracts for the carrying out of the electric lighting of the town n the general lines of that report, it being understood that the otal cost shall not exceed £26,500, and that the installation shall uffice for 5,000 lights of 16 c.p. or their equivalent."

COMPANIES' MEETINGS.

CITY AND SOUTH LONDON RAILWAY.

The adjourned general meeting of this Company, to consider the uestion of raising further capital, was held on Tuesday at Winchester House, Mr. G. C. Mott (chairman) presiding. A report of the proceedings which gave rise to this adjournment will be found in our issue for June 19.

The **Chairman** said they would remember that at the meeting held on June 16 it was agreed that in the interval the Directors should have a conference with some of the larger shareholders of the Company to see whether any method could be devised for raising the additional capital in a better and more economical way than had been proposed. That conference had been held, and the matter had been very fully and carefully discussed; and in the result it was agreed by all of them, he thought, that the recommendation made to them by the Directors was the best and most economical way of raising the money. It was proposed to slightly modify the resolution, and this quite met the view of the Directors themselves—namely, that although they created £150,000 of preference shares, they should be authorised at the present moment to issue only 5,000 of them—that was £50,000. It had also been thought desirable that the preference shares should carry with them the ordinary voting power, the same as the ordinary shareholders had. He concluded by proposing: "That the resolution passed at the general meeting of the Company, held on August 12th, 1890, relating to the creation of the new capital authorised by the City and South London Railway Act, 1890, be, and the same is hereby, cancelled and annulled, except as to the creation or issue of 5,000 ordinary shares of £10 each, part of the total number of 20,000 shares authorised by the said resolution." This was simply cancelling what they did nearly a year ago in creating all the balance as ordinary capital. They must cancel this before they could create the preference shares.

The motion was seconded by **Mr. S. Hanbury**, and carried unanimously.

The **Chairman** then proposed the following resolution: "That £150,000 of the share capital, being the balance of the £200,000 authorised to be created by the City and South London Railway Act, 1890, be, and the same is hereby, created in 15,000 preference shares of £10 each, bearing interest at the rate of £5 per cent. per annum, and that the Directors be, and that they are hereby, authorised to issue 5,000 of such preference shares, in such amounts, at such times, and on such terms and conditions as they may think fit. The holders of the preference shares hereby created shall be entitled to vote on the same scale of voting as the holders of ordinary shares."

Mr. Hanbury seconded the resolution.

A **Shareholder** asked whether the interest was cumulative.

The **Chairman** said that they could not make it cumulative under their Act. The shares were, in fact, ordinary shares, having a priority as regarded interest. They must remember that the amount of preference capital they created was very small in proportion to the ordinary capital—much smaller than in the case of any other railway company.

The resolution was carried unanimously.

COMPANIES' REPORTS.

NATIONAL TELEPHONE COMPANY.

The report of the Directors for the year ending April 30 states that there is a balance to the credit of net revenue account of £194,821. 8s. 1d., after providing, among other charges, for the expenses of issuing new debenture stock, and the accrued interest thereon to April 30, 1891. Of this amount the sum of £62,973 has been absorbed by the payment of an interim dividend on the preference shares at the rate of 6 per cent. per annum, and on the ordinary shares at the rate of 5 per cent. per annum for the first six months of the year. The Directors propose to pay a further dividend on the preference shares at the rate of 6 per cent. per annum, and on the ordinary shares at the rate of 7 per cent. per annum for the last half of the year, which will absorb a further sum of £86,365. 19s., leaving a balance of £45,482. 9s. 1d. Out of this amount they propose, under article 113 of the articles of association, to transfer to reserve account £40,000, bringing up the amount of the reserve fund to £93,500. There will then remain £5,482. 9s. 1d. to be carried forward to next year. The extension of the Company's business during the last year has been so large that notwithstanding the heavy reduction of rates which the Directors thought it wise to make in the provinces, in view of the expiration of some of the Company's most important patents, the gross revenue, which last year stood at £411,114. 14s. 1d., reached £418,560. 7s. 8d. on April 30, 1891, and is still steadily increasing. The number of exchange and private line subscribers over the whole of the Company's system, including the South of England district, which last year was 29,257, was on April 30, 1891, 35,440, an increase of 6,183 subscribers during the year, and the number of subscribers is still increasing. The Directors are still acting upon the conviction that it is of vital importance to continue the policy of developing and improving the Company's system, and of giving greater facilities to the public. The accrued rental for the year ending April 30, 1890, was £363,704. 17s. 5d. For the present year it is £422,378. 6s. 2d. The working expenses for the year ending April 30, 1890, amounted to £148,457. 0s. 9d., being 40·7 per cent. on the accrued rental, whilst the working expenses of this year amount to £184,056. 9s. 6d., being at the rate of 43·5 per cent. on the accrued rental. The Directors have taken over the business of the South of England Telephone Company, Limited, which is now merged in this Company. On the amalgamation, in July, 1889, of the three principal companies, it was thought desirable that the customary annual retirement of one-third of the Directors should not take place at the end of the first year, in order that the numerous arrangements rendered necessary by the amalgamation and reorganisation of the Company might not be interfered with. These having been now completed, and two of the provincial companies—the Northern and South of England Telephone Companies—having been absorbed, the Directors think they ought all, at this meeting, to place their offices at the disposal of the shareholders, and submit themselves for their approval. They, therefore, now all retire, and being eligible, offer themselves for re-election. The auditors, Messrs. Welton, Jones, and Co., retire, and are eligible for re-election.

NEW COMPANIES REGISTERED.

Babcock and Wilcox, Limited.—Registered by Hollams, Sons, Coward, and Hawksley, Mincing-lane, E.C., with a capital of £240,000 in 10,000 preference shares of £10 each and 14,000 ordinary shares of £10 each. Object: to acquire the undertaking heretofore carried on in London, Glasgow, and elsewhere, other than in the United States of America and the Island of Cuba, by the Babcock and Wilcox Company of New York, in accordance with an agreement expressed to be made between the Babcock and Wilcox Company of New York of the one part and the Company of the other part, and to carry on business as manufacturers of water-tube steam boilers, and generally the business of engineers and manufacturers of machinery of every description. The first subscribers are:

	Shares.
C. A. Knight, 114, Newgate-street, E.C.	1
W. Shaw, Upper Highlever-road, North Kensington	1
H. P. Smith, 1, Farley-terrace, Wilna-road, Earlsfield	1
J. E. Slack, 24, Parkhurst-road, Holloway, N.	1
W. Reavell, 114, Newgate-street, E.C.	1
R. Maurice, 114, Newgate-street, E.C.	1
E. Stinton, 114, Newgate-street, E.C.	1

There shall not be less than three nor more than seven Directors. The first are Andrew Stuart, Sir William Arrol, Arthur Telford Simpson, J. G. Mair Rumley, Charles Albert Knight, James Hermann Rosenthall, and Henry Faustin Knight. Qualification, £2,000. Remuneration, £2,000, divisible.

Bournemouth Lighting Company.—With a capital of £50,000 in shares of £5 each, the Bournemouth and District Electric Supply Company, Limited, has been formed to undertake the supply of electric light and power in Bournemouth, and for that purpose to take over the central station, business, and undertaking, under provisional orders, of the Brush Electrical Engineering Company in Bournemouth. The arrangements under which the Company is to acquire the undertaking and property provide for the payment of £17,275, at the option of the Company, either wholly in cash or in shares, or partly in cash and partly in shares. A minimum dividend, at the rate of 5 per cent. per annum, upon the paid-up capital is guaranteed by the Brush Company for the first three years.

Gloucester Electricity Supply Company, Limited.—Registered by Sydney Morse, 4, Fenchurch-avenue, E.C., with a capital of £100 in £1 shares. Object: to carry on business as electrical engineers, electricians, etc.

Middlesbrough Electricity Supply Company, Limited.—Registered by Sydney Morse, 4, Fenchurch-avenue, E.C., with a capital of £100 in £1 shares. Object: to carry on generally the business of electrical and mechanical engineers, etc.

Queen Anne's-mansions Lighting and Heating Company, Limited.—This Company has been formed, with a share capital of £60,000 in 3,000 four and a half per cent. cumulative preference shares of £10 each and 3,000 ordinary shares of £10 each, for the purpose of taking over and working a contract for the heating and supplying electric light and hydraulic power to Queen Anne's-mansions and other houses and buildings in the neighbourhood, and for the distribution and purification of the water supply thereto, together with a lease of the basement of the premises.

Rochdale Electricity Supply Company, Limited.—Registered by Sydney Morse, 4, Fenchurch-avenue, E.C., with a capital of £100 in £1 shares. The objects of this Company are sufficiently indicated by the title.

Stoke-on-Trent Electricity Supply Company, Limited.—Registered by Sydney Morse, 4, Fenchurch-avenue, E.C., with a capital of £100 in £1 shares. Object: to carry on the business of an electrical engineer in all its branches.

CITY NOTES.

Brazilian Submarine Telegraph Company.—The receipts for last week were £5,653.

Eastern Extension Telegraph Company.—The Company has declared an interim dividend for the quarter ended March 31 last of 2s. 6d. per share, payable on the 15th inst.

Bell's Asbestos Company.—The Directors have declared an interim dividend of 2s. 6d. per share, free of income tax, for the half-year ended June 30, being at the rate of 5 per cent. per annum.

City and South London Railway.—The receipts for the week ending 27th inst. were £697, against £721 for the preceding week. The total receipts for the four weeks ending June 27 were £3,054.

Western and Brazilian Telegraph Company.—The receipts for the week ended June 26, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, were £3,833.

St. James's Electric Lighting Company.—An interim dividend at the rate of 7 per cent. per annum has been declared on the ordinary shares for the half-year ending June 30th. The transfer books will be closed from July 1st to July 10th, both days inclusive.

Young v. The American Telephone Company. On the application of two of the defendants in this case (the American Telephone Company and Mr. Mason, the president of the Company) Mr. Justice Kekewich last week stayed all further proceedings in the action on the ground that they were frivolous and vexatious, and that the matter had been disposed of in two previous actions.

PROVISIONAL PATENTS, 1891.

JUNE 22.

10612. **Electrical transformers for rotary-phase currents.** Siemens Bros. and Co., Limited, 28, Southampton-buildings, London. (Siemens and Halske, Germany.)

10613. **Glow lamps for rotary-phase currents.** Siemens Bros. and Co., Limited, 28, Southampton-buildings, London. (Siemens and Halske, Germany.)

JUNE 23.

10636. **Improvements in electric telegraph printing.** Marshall Arthur Wier, Fairview, Kingston-on-Thames.

10664. **Improvements in or connected with the insulation of electrical conductors.** Herbert Tom Harris, 433, Strand, London.

10697. **An improved method of and apparatus for protecting dynamo-electric generators and other apparatus from the effects of lightning.** Henry Harris Lake, 45, Southampton-buildings, London. (The Thomson-Houston International Electric Company, United States.) (Complete specification.)

10703. **Improvements in the manufacture of the arms or attachments of telegraph poles for carrying insulators.** Howard Cochrane Jobson, 7, Staple-inn, London.

10704. **Electric directing apparatus for use in cabs, carriages, or on boats, railway trains, and the like.** Arthur Douglass, 13, Southampton-street, Pentonville Hill, London.

JUNE 24.

10729. **Dynamo or electromotor ring armature construction.** Gilbert Betteley Luckhoff and Emil Henri Hungerbuhler, 214, Whitehorse-road, Croydon, London.

10762. **Improvements in call boxes or like electrical communicators.** George Thomas Cashmore, 6, Livery-street, Birmingham.

10778. **Improvements in electric arrangements and apparatus for locking railway signal and point levers, also applicable for other purposes.** John Audley Frederick Aspinall and Henry Albert Hoy, 45, Southampton-buildings, London.

10787. **Improvements in materials for insulating electric conducting wires, and for carbons and incandescent filaments for electric lighting.** Gustave Adolphe Cannot, 35, Southampton-buildings, London.

JUNE 25.

10822. **A compound preparation to be used as a substitute for guttapercha and similar products for insulating and waterproofing purposes.** Charles Napier Jackson, 64, Hanley-road, Hornsey Rise, London.

10821. **Improvements in firing guns by electricity.** William Balch, 17, Queen's-road, Chelsea, London.

10832. **Improvements in electrical transformers.** Woodhouse and Rawson United, Limited, 88, Queen Victoria-street, London. (Ernest Preschlin, Germany.)

10838. **Improvements relating to the lighting of trains by electricity.** William Brew, 4, South-street, Finsbury, London.

10839. **Improvements relating to dynamo-electric machines, and to electromotors.** William Brew, 4, South-street, Finsbury, London.

10843. **Improvements in apparatus for regulating electric currents.** Jules Ferrand, 46, Lincoln's-inn-fields, London.

10860. **Improvements in means or mechanism for regulating the lighting intensity of electric lamps.** Robert James Spreadbury, 37, Chancery-lane, London.

JUNE 26.

10877. **Improvements in or connected with means of connecting ropes or cords, and hauling electric or other cables.** Arthur Annesley Voysey, 15, Water-street, Liverpool.

10887. **An apparatus for lighting by electricity large numbers of gas burners simultaneously and cheaply, as compared with existing methods.** James Walker and Joseph Hampshire, 2, Union-street, Dewsbury.

10894. **Electrometers.** Charles Vernon Boys, 11, Alexander-square, London.

10932. **Improvements in apparatus for repairing commutators of dynamos** Arthur Bernard Gill, Shirley House, The Avenue, Grove Park, Lee.

10933. **Improvements in commutators of dynamo-electric machines.** Arthur Bernard Gill, Shirley House, The Avenue, Grove Park, Lee.

10934. **Improvements in dynamo-electric machinery, and in the regulation thereof.** John Augustine Kingdon and Arthur Bernard Gill, 29, Marlborough-hill, London.

JUNE 27.

10939. **Improvements in conductors for electric lighting, electric bell circuits, and like purposes.** Henry Alexander Mavor, William Arthur Coulson, and Sam Mavor, 62, St. Vincent-street, Glasgow.

10969. **Dynamo-electric machines.** William Aldred, 5, Brightside Bank, Sheffield.

10977. **Improvements in galvanic batteries.** Auguste de Meritens, 47, Lincoln's-inn-fields, London. (Date applied for under Patents Act 1883, Section 103, 28th November, 1890, being date of application in France.)

10978. **Improvements in insoluble porous anodes for electrolytical processes.** Siemens Bros. and Co., Limited, 28, Southampton-buildings, London. (Siemens and Halske, Germany.)

10983. **The electro-medication belt or pad.** John Henry Nicholson and The Aurophone Company, Limited, 21, Bedford-square, London.

11004. **Improvements in and relating to the manufacture of plates for electric accumulators.** Constant Rousseau, 45, Southampton-buildings, London.

SPECIFICATIONS PUBLISHED.

1890.

9061. **Electric meters.** De Ferranti and Wright. 11d.

10736. **Electric light fittings for medical purposes.** Oudin and Kratz-Boussac. 8d.

10805. **Electric motors.** Mills (Edison). 11d.

11720. **Electrical fuses.** Jones and others. 6d.

12013. **Electric insulating compound.** Sinclair and Mackay. 4d.

12244. **Incandescent electric lamps.** Newton (Swan). 8d.

13491. **Electric belts.** Harness. 8d.

1891.

5637. **Electric converters.** Barker (Farmer). 8d.

6390. **Transmitting rotary motion, etc.** Johnson. 11d.

6831. **Dynamo-electric machines.** Parcelle. 8d.

7715. **Storage batteries.** Washburn. 6d.

7778. **Electric conductors.** Thompson (Williams). 8d.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Brush Co.	—	2¼
— Pref.	—	1⅝
India Rubber, Gutta Percha & Telegraph Co.	10	19½
House-to-House	5	5
Metropolitan Electric Supply	—	9¼
London Electric Supply	5	2¼
Swan United	3¼	4½
St. James'	—	6½
National Telephone	5	4¼
Electric Construction	10	7½
Westminster Electric	—	4½

NOTES.

Dr. Louis Duncan, of Johns Hopkins University, has sailed from America for England.

Royalty and Science.—Prince George of Greece visited Edison's laboratory last week.

Carlsbad.—On Thursday, last week, the town of Carlsbad was lighted by electricity for the first time.

Mica.—An extensive deposit of mica, so largely used for insulating purposes, has been discovered at Mario, North Carolina.

Water Power in California.—In a few months Yreka, California, will be lighted by electricity obtained from water power.

Silent Engine.—Why was the gas engine used in a certain testing institution not a hundred miles from Charing Cross, called a "silent" gas engine ?

Balloon Struck.—The balloon recently imported to the Chicago Exhibition was struck by lightning on Monday, and the two aeronauts were severely injured.

Electric Drilling. — An Edison electric drill has recently demonstrated its utility by drilling a 2in. hole through 20ft. of solid granite in four hours.

Bootle.—The Finance Committee of the Bootle Town Council thinks that they ought to have the electric light as soon as possible. They have two boilers but no engines.

Exhibition at Paris.—The exposition which opens in the Palais d'Industrie on the 23rd of this month at Paris promises to have some interesting electrical exhibits.

Electric Carriage.—Chas. Reitz, of Indianapolis, has built an electric carriage driven by a motor and 30 cells, which will be shortly on the streets. The outfit weighs 500lb., and runs 8 to 10 hours.

Institution Laboratories.—The Belgian Société des Electriciens have in contemplation the establishment of an electrical laboratory similar to that of the Société Internationale des Electriciens at Paris.

The Telautograph.—The writing telegraph was tested on June 21st over 1,030 miles of ordinary telegraph line, and a number of messages were sent (by an expert of their own) successfully over this distance.

Morley.—At the meeting of the Morley Town Council, on Monday, it was resolved that the Council would be prepared to receive estimates as to the cost of establishing and carrying on a supply of electric light within the borough.

Railway Dynamos Struck.—Four of the dynamos at the power-house of the electric street railway at Richmond, Virginia, were recently struck by lightning and the armatures destroyed. Several cars were also struck, but no one was injured.

York.—The new municipal buildings in York, just opened, are lighted throughout with gas, but electric light wires have been laid through the whole building, so that the electric light can be introduced as soon as an installation is provided in the city.

Development of Telegraphy.—An interesting paper was read before the Canadian Society of Civil Engineers by Mr. D. H. Keeley, of Ottawa, on "Developments in Telegraphy—Wires Multiplexed and Interchangeable," published in pamphlet form.

Royal Society of Edinburgh.—At the meeting of the Scottish Royal Society, on Monday, communications were presented by Prof. Knott on "The Electric Resistance of Cobalt at High Temperature" and "The Thermo-electric Position of Cobalt and Bismuth."

Parliamentary Powers.—Petitions have been presented in the committee stage against the London County Council (General Powers) Bill by the Greenwich District Board of Works, the London Electric Supply Corporation, and the Westminster Electric Supply Corporation.

Rhyl Pavilion.—A splendid new pavilion is being erected at Rhyl, to be completed by Aug. 15th. At the meeting of the directors, on Saturday, the question of electric lighting the new pavilion and the whole of the pier was discussed, and tenders are invited for carrying out the same.

Eastbourne.—The town clerk of Eastbourne has submitted the recommendation passed at the last meeting of the Eastbourne Town Council as to the lighting of the borough by oil or electricity, that the borough surveyor make enquiries from other boroughs upon the matter, and report fully thereon.

Water Power in Australia.—The proposal to utilise the River Yarra, at Warrandyte, near Melbourne, for generating electricity, has, it is said, taken definite form. A water license has been granted to Alcock and Co. for 15 years, and a company, according to the *Australasian Manufacturer*, is to be floated in London.

Burton Electric Heater.—The electric car heater invented by Dr. Burton is found by Lieutenant Dana Greene, who is their consulting electrician, to take a normal current of three amperes from the line, and the cost is given at 2d. a day per car. The John Scott legacy medal has been awarded to the inventor.

The World's Fair.—The finances of the Columbian World's Fair, at Chicago, are in a favourable condition, ten million dollars having been subscribed. The work of preparing the grounds of 600 acres extent is virtually completed, except the dredging of the lagoon. The contracts for many of the main buildings have been awarded.

The City of London Company.—Next week will probably see the formation of the new large company for the lighting of London, to take over the plant and contracts of the City of London (Pioneer) Electric Lighting Company. The latter shares will be taken over at a very considerable premium, and a good field of success is open for the large company.

Rochdale.—At the meeting of the Gas Committee of the Rochester Town Council on July 1, the town clerk laid before the meeting a notice of the intention of the Rochdale Electricity Supply Company, Limited, to apply to the Board of Trade for a provisional order (to be confirmed by Parliament in the ensuing session) to supply electricity in the borough.

Taunton Exhibition. — It was suggested at the Electrical Trades Section of the Chamber of Commerce that the Taunton Exhibition would better suit the convenience of exhibitors if held later. Mr. Massingham did not think it possible to alter the date, and as opinions were equally divided, it was finally resolved to give cordial support to the exhibition.

Demagnetisation of Watches.—Mr. J. S. Matheson, of Leith, owing to the number of watches spoilt at the Edinburgh Exhibition, has recently patented a process for thoroughly demagnetising watches so affected. We were of opinion that the system of gradually diminishing alternating magnetisations for this purpose was sufficiently practical and open to all.

Telephone in Honolulu.—The telephone is more used in Honolulu than any other place, the two rival companies cutting rates until every soda-water stand has its telephone, and all the marketing is done by this means. Even trams and railway trains are started by telephone, and men use their legs as little as possible in this hot clime with such facilities for verbal intercourse.

Steam v. Electricity.—A very suggestive occurrence has just taken place in the abandonment of the steam railway traffic on the 10-mile line between St. Paul's and Mineapolis in consequence of the competition of the electric railway. The *Railway Review* regards the problem as serious, and warns railway engineers that they must now be prepared to face fierce competition on the shorter lines.

Public Lighting in South London.—The Deptford Company have not yet received any orders for public lighting, except the small area of St. George's-circus. The corporation are, however, sanguine of eventually securing the public light over a considerable part of the district, which includes Westminster Bridge-road, Newington Causeway and Butts, Southwark-street, and Borough High-street.

Loughborough.—At the monthly meeting of the Loughborough Town Council, on Monday, the Mayor, on the passing of the General Purposes Committee's minutes, said, with reference to the electric light, they would remember that a committee was appointed in anticipation of some company seeking to obtain powers. It might interest the Council to know that no application had been made by any company.

Clerkenwell.—The Clerkenwell Vestry had before them, at their meeting on Wednesday, a letter from the Brush Electric Engineering Company, giving statutory notice of their intention to apply to the Board of Trade for a provisional order to supply electricity within the area of Clerkenwell. Also similar letters from the County of London Electric Lighting Company, and the Camberwell and Islington Electric Light and Power Company.

Audenshaw (Lancs.).—At the monthly meeting of the Audenshaw Local Board, Mr. Cooper said he had received a letter from an electric light company, but it was so badly written that he could scarcely read it. It was not thought necessary to read the letter. The Council felt they would have to follow the lead of greater authorities, and they could not do anything. The letter was then handed to the members for perusal.

Faraday and Sandemanian.—Referring to an extract which appeared some days ago respecting Faraday's religious and scientific opinions, the elders of the church known as Sandemanian, meeting at Barnsbury-grove, have written to the *Daily Telegraph* to state "that Faraday's scientific work never came into conflict with his faith in the Scriptures, and was never the cause of any trouble or misgiving to his church friends."

Stroud.—The Stroud Board of Health are exercised over the question of public lighting. The Lighting Committee drew attention to the improvements in the electric light, and suggested that, if the Board desired, enquiries might be made as to the cost of electricity. It was suggested that application should be made to Mr. George Norman, of Cheltenham, for information, that gentleman having made strict investigations all over England.

Electric Executions.—Four criminals were executed by electricity on Tuesday in New York. The official spectators were sworn to secrecy. Dr. Rockwell states that everything passed off quietly and expeditiously, death being instantaneous. Dr. Daniels, on the other hand, states that the Kemmler scene was repeated. By one report two shocks each were given; another states that only one shock each was given, and no burning took place.

Incandescent Lamp Manufacture.—It is announced that Captain François Walter, captain of artillery, and professor in the technical military school at Vienna, has made an invention which will revolutionise the incandescent lamp trade, being a method of welding other metals to glass instead of platinum. This kind of vague announcement, however, is worthy of little credence at present; technical details to warrant any attention being given to it are not to hand.

Kinetograph.—Another rival to Edison's invention of the kinetograph is found in an English invention, the "kinesigraph" of Mr. W. Donisthorpe, a barrister, and Mr. W. C. Crofts, Westminster-chambers, 7, Victoria-street, Westminster. Like Edison, these gentlemen take a series of consecutive photographs on a continuous film of sensitive surface, and combine them on a screen by the aid of an optical lantern. The date of their patent is August 15, 1889, or nearly two years ago.

Liege.—For parents thinking of sending their children abroad Liège offers many advantages. It has a fine university, with over 70 professors and 1,500 students, with new physiological, engineering, and chemical laboratories. The French spoken is the best in Belgium, and as students attend from all countries, by judicious choice of friends other languages may be learnt. Only five or six British students yet attend, but it is probable when its advantages are better known more will go.

The Phonopore.—We believe these instruments are being made in some quantities for practical work and tests. Some 250 of these instruments, in Morse form, working with what may be termed the ghost or skeleton of a current, which does not affect the ordinary instruments, are being made, and we understand that a severe test is being arranged by the chief electrician of one of the large railway companies. If this highly ingenious but hitherto delusive instrument can only be made absolutely practical, the possibility of doubling or trebling the ordinary instruments on a single railway line would certainly open a large field of additional usefulness.

Telephones and Tramways.—With reference to the recent disputes as to the vested interests of telephone companies in the "earth" circuit, it is interesting to note that in the United States, before the Ohio Supreme Court, it has just been decided that, as the roads in a municipality are for the purpose of facilitating public travel, the previous use by the telephone company of this road, or part of it, as a circuit does not prevent the electric tramway using it for its proper purpose, and that the telephone, as against the tramway company, will not have a vested interest and exclusive right to the use of the ground circuit as part of the telephone system.

Lighting of London.—At the meeting of the Commissioners of Sewers on Tuesday, the clerk said he had received a notice from the Brush Electrical Engineering Company of their intention to apply in the next session of Parliament for a provisional order authorising them to supply electrical energy for any public or private purposes within the City of London. Also a notice from the Laing, Wharton, and Down Construction Syndicate of their intention to apply in the next session of Parliament for a provisional order authorising the said syndicate to amend the City of London (East District) Electric Lighting Order, 1890. These communications were referred to the Streets Committee for consideration.

Ferranti System.—Mr. Ferranti stated at the meeting of the Municipal Engineers the other day, that high-pressure electrical engineers could now guarantee that 85 per cent. of the total electricity generated in the station could be delivered and sold to customers, and that if they could guarantee this, it was evident that in practice they could surpass this amount. We understand that the Deptford station is now supplying about 30,000 lights. The districts around Blackfriars are being wired, and several installations are being supplied at Deptford and Bermondsey. At Havre, where the Ferranti system is in force, a complete new low tension network has been laid down and a new 500 h.p. dynamo added.

Primary Battery Cars.—Experiments are being made by Mr. George B. Pennock, in Peoria, with a primary battery car. Mr. Pennock was assistant to Prof. Page, in 1851, when he ran an electric car at 20 miles an hour between Washington and Blandesberg, and is still a great believer in zinc. The Pennock battery consumes ¾lb. of zinc per horse-power per day, and even at double this he gives the cost at 1¼d. per horse-power a day. It is stated that in a few days the first electric locomotive in the world to be driven by primary batteries on the regular steam railways will be at work. A company is formed with half a million dollars capital, and Mr. Pennock announces that he proposes to run a passenger train between Chicago and New York during the World's Fair.

New Chemical.—Prof. Traube, of Breslau, has noticed the formation of a crystalline deposit on the anode when electrolysing an acid containing at least 40 per cent. of sulphuric acid. Prof. Traube assigns to this product the formula SO_4, which might be written SO_2O_2 by analogy with oxygenated water, H_2O_2, whose properties are of the same order. In fact, the compound SO_4 put into contact with oxide of lead forms sulphate of lead with disengagement of oxygen. M. Berthelot isolated a compound, S_2O_7, by electrolysis of sulphuric acid, and named it persulphuric acid. There is reason to believe, says the *Bulletin de l'Electricité*, that this persulphuric acid is a combination of sulphuric anhydride and the compound SO_4. We may thus write—$S_2O_7 = SO_3\ SO_4$.

Electric Bells.—Tenders are invited by the London County Council for making perfect and maintaining in thorough repair the whole of the electric bells and wires, and the apparatus connected therewith, fixed in the land and river stations of the Fire Brigade, and in houses used as lodgings for firemen. Specification, form of tender, and particulars may be obtained on application at the County Hall, Spring-gardens. Each tender must be accompanied by a declaration that the person tendering pays the rates of wages and observes the hours of labour usually accepted as fair in the trade. Tenders, addressed to Mr. H. De la Hooke, clerk of the Council, Spring-gardens, S.W., endorsed "Tender for Maintenance of Electric Bells," are to be sent in by noon on the 14th inst. Persons tendering must have offices and workshops in the county of London.

Burton.—The Gas and Electric Lighting Committee of the Burton Town Council presented a report last week in which they asked permission to exercise and carry out the provisions of the Burton-upon-Trent Electric Lighting Order, 1890, to obtain a site for electric lighting works, and to advertise, subject to specifications and conditions, for tenders and proposals of electric lighting systems, the execution of works, and the supply of machinery at a fixed sum. It was also stated that it would be necessary to obtain a piece of land, 4,054 square yards in extent, adjoining the gas works, and as Mr. Fenning had consented to lease the ground at £16. 17s. 10d. ground rent on condition that trade erections were constructed thereon to the value of £500, the committee recommended that the land should be secured. It was determined to advertise for tenders.

"The Journal of Gas Lighting."—It would hardly be courteous to say this paper deliberately propagates falsehoods, but until it can advance proof of the following statement we shall hold that its dictum is absolutely unworthy of belief. Referring to Mr. W. H. Preece's address to the Municipal Engineers, it says: "which we (the *Journal of Gas Lighting*) alone, of all the technical journals, specially reported last week." The *Journal of Gas Lighting* has a "bee in its bonnet" so far as electricity is concerned, and according to our judgment is not unwilling to mislead its readers upon such matters. The above statement as regards reporting is absolutely false. The *Electrical Engineer* and the *Contract Journal*, two technical papers, were represented throughout the meeting, and at all the visits to works. Not only so, but the *Electrical Engineer's* report was revised by the author.

The Thunderstorm.—London was visited with a very fierce and prolonged thunderstorm on Wednesday afternoon, during which the flashes of lightning and peals of thunder were almost incessant. The rain fell in torrential manner almost unsurpassed in the tropics, and ·6 of an inch was registered within an hour or so. Considerable damage was done, several houses were set fire to, and a man standing under a tree at Tottenham was struck and his clothes literally torn to ribbons, though the man was fortunately not killed. For the first time in its history the Royal Botanic Society had a tree struck by lightning. In the gardens, Regent's Park, a poplar was, at 4.30, during the thunderstorm, stripped cleanly in places of huge pieces of its bark and timber. Some workmen, who were busy preparing for the society's *fête*, were close to the tree, but sheltered beneath the wet canvas of the adjacent tents they suffered no hurt.

Kingswood.—At the meeting of the Kingswood Local Board last week, the clerk read the correspondence that had passed between himself and Messrs. Christy and Son, Chelmsford, who had tendered for the lighting of the district by the electric light. After opening the tenders, he had, in accordance with instructions received, written to Messrs. Christy asking where the members of the Board could inspect an installation laid for public lighting purposes, and also certain questions as to the decrease in the candle-power through wear. A reply had been received giving the required information, and stating that the nearest public installation laid by the firm was at Chelmsford, near London. An inspection of this service would be especially useful to the Board, because it was almost exactly similar to the requirements of Kingswood. Private installations had been laid at Messrs. Grace Bros. and Messrs. H. H. Budgett, Bristol, which could be inspected if desired. An inspecting deputation was appointed.

High-Tension Transmission in Vienna.—M. Zipernowski has invented, it is stated, a combined system of utilising continuous and alternating currents, with the idea of working in Vienna an electric tramway travelling at 25 miles an hour. A generating alternate-current dynamo placed at some distance away, giving a current of 10,000 volts, will drive a motor in a secondary station. This motor, which has to be put into step with the generator, will drive a continuous-current dynamo, whose current will be used to feed the car motor. This system will enable those natural forces to be used which are otherwise too far away to be utilised by means of continuous currents alone. The carrying out of this scheme, if intended to be a practical project, will be watched with equal interest to the transmission of power to Frankfort. By the use of a subsidiary steam or other engine to put the second alternate dynamo in step, the necessity of a third wire will, we suppose, be obviated.

The Supply of Power from Central Stations.—About 20 years ago a bequest of £500 was made to the Society of Arts by Mr. T. Howard for the purpose of presenting a prize to the author of a treatise on motive power. The prize having on several occasions been offered without any practical result of value, the council considered that the most useful way of dealing with it would be to invite some eminent authority to deliver a course of lectures on a subject coming within the terms of the trust, on the understanding that the lectures should afterwards be published as a treatise. The result was that Mr. Anderson delivered, in 1884-5, the valuable course which were afterwards republished under the title of "The Conversion of Heat into Useful Work." Since that time the interest of the fund has accumulated to a sufficient extent to allow the council to repeat their action, and they have accordingly invited Prof. Unwin to deliver, during the next session, a course of lectures on "The Generation of Power at Central Stations, and its Distribution therefrom."

London County Council.—Sanction is given by the London County Council to mainlaying by the Kensington and Knightsbridge Company at Rutland-gate; to the Electricity Supply Corporation across the Strand to the Adelphi, to Northumberland-street, Whitehall, Charing Cross, Trafalgar-square, Pall-mall, St. Martin's-lane, Haymarket, and Leicester-square; to the Westminster Company in Buckingham-street, Queen Anne's-gate, Downing-street, Richmond-terrace, Parliament-street, Great George-street, Broad Sanctuary, Victoria-street, etc.; to the London Electric Supply Corporation for trunk mains from Cockspur-street through St. James's Park to Buckingham-gate; to the Metropolitan Company, in Leicester-place and across Cranbourne-street. The Parliamentary Committee report that in the opinion of the Highway Committee, in which they concur, the substitution of the Vestry of Chelsea for the Council as electric lighting authority in that parish would be unsatisfactory, and that they have directed a petition to be prepared and, if necessary, presented against the Bill.

Conversazione.—The president of the Institution of Electrical Engineers (Mr. William Crookes, F.R.S.) and Mrs. Crookes received a brilliant company of over 800 guests at a *conversazione* in the galleries of the Royal Institute of Painters in Water Colours, on Monday. The visitors greatly enjoyed the very fine exhibition of portraits, the band of the Coldstream Guards, the strawberries, and coffee-ices, and interchange of social amenities. Besides the members of the Institute—Sir Wm. Thomson, Mr. W. H. Preece, F.R.S., Mr J. W. Swan, Dr. S. P. Thompson, Prof. Ayrton, F.R.S., Prof. Perry, F.R.S., Dr. Hopkinson, and others—were many noted guests, among them being Sir F. Abel, K.C.B., Sir James Douglas, Dr. Gladstone, F.R.S., Earl Russell, Duke of Marlborough, Sir Edwin Arnold, Sir F. Bramwell, F.R.S., H. Perigal, F.R.A.S., General J. T. Walker, F.R.S., Sir Benj. Baker, K.C.M.G., Sir G. B. Bruce, Hon. H. A. Dillon, Sir Philip Magnus, Sir E. J. Reed, Sir H. Doulton, Mr. W. J. Karner and Mr. E. L. Corthell (Chicago Exhibition), Mr. Wimshurst, Mr. Ferranti, Dr. Ernest Hart, Mr. Ganz, and many others.

Electrical Manufacture of White Lead.—In an article in the *Revue Industrielle* for July 4, the electrolytic process of forming pure white lead is discussed from its theoretical and practical points of view. The description is given of a commercial process recently patented, the adaptation of a well-known laboratory experiment. In a suitable vessel is prepared a solution of nitrate of ammonia and nitrate of soda, five parts by weight of each to 100 parts of water. Two pigs or plates of lead are placed therein, and the bath is saturated with carbonic acid in a nascent state. This is economically obtained by burning lime. When the bath is rendered almost neutral, the two pieces of lead are put into connection with the poles of a dynamo giving 15 amperes per 100 square centimetres of surface of lead in contact with the positive electrode. As soon as current passes, white lead appears at the surfaces of the two pieces of lead, and by continuing to saturate the bath with carbonic acid, and prolonging the passage of the current, the whole can be transformed into white lead, which is then taken out of the bath, washed in a 6 per cent. solution of salt water, and dried, producing a commercial product with exceptional covering qualities, composed of one part of hydrated oxide of lead to two of carbonate of lead. The only expense of manufacture after the bath is set up is in the production of the carbonic acid and the current, and this is stated to be considerably less than that of the present forms of apparatus in outlay, wages, and time.

Registering Instruments.—Science progresses by the study of fact, by the evolution of theory, the adaptation of theory and fact to use, and the consequent study of results. In science, to have results is not enough: we must have records of these results, records from day to day, from year to year. Therefore, the success which attends all really good attempts to satisfy the demand for registering instruments. No firm has done more in this way than the well-known one of Richard Frères, 8, Impasse Ferrard, Paris, whose London branch is 43, London-wall (manager, Mr. J. A. Berly). We have before us their catalogue of measuring, controlling, and self-registering instruments for scientific and industrial purposes. "We manufacture," they say, "every kind of registering instrument that may be required in science and industry. Should any of our customers fail to find in this catalogue the instruments they desire, we will, on their indication of the results they have in view, and the phenomena they intend to control, study the type of registering instrument suitable for their purposes," and endeavour to bring out such an instrument. They produce three kinds of measuring apparatus—engineering, electrical, philosophical. Their list of medals and awards is very numerous, embracing those from 1845 to 1890. We find in the catalogue registering anemometers, barometers, chronographs, dynamometers, hygrometers, speed recorders, water-level indicators, pressure gauges, pyrometers, thermometers, volt and ammeters, charge and discharge recorders, and recording electricity meters, besides numerous others in special departments of meteorology. We advise all electrical engineers to possess themselves of this valuable catalogue.

Chelsea.—The Select Committee of the House of Lords last week, presided over by Lord Basing, considered the Electric Lighting Bill to confirm a provisional order granted by the Board of Trade to the New Cadogan and Belgrave Electric Supply Company, Limited, to enable the company to supply the electric light to a part of the parish of St. Luke, Chelsea. The Bill was opposed by the Vestry of Chelsea on the ground that it made the London County Council the local authority under the order. Mr. T. Holland, clerk to the Vestry, said the Electric Lighting Act of 1882 and 1888 specified the Vestry as the local authority for all purposes under the Acts, and Parliament never intended to give control or powers over electric lighting to any other body than the local authority as ined by these Acts. By making the London unty Council the local authority a concurrent jurisdiction ould be established, which might, and probably would, d to a conflict between the Vestry and the County uncil, and when the Vestry became the undertakers the unty Council would exercise an authority over their pply, which should be left to the inhabitants of the strict. The chairman said he saw no reason why the estry should not be the local authority. Mr. Cripps, rliamentary agent, representing the London County ouncil, said the Vestry raised no objection to the ouncil being the local authority under the order of the ondon Electric Supply Corporation of 1889. Mr. Holland plied that that order extended to nearly the whole of e metropolis, and the parish of Chelsea only formed an tegral portion of that area. Therefore, the undertaking ould not in any sense be regarded as a local one. The hairman said the committee were unanimously of opinion hat the Vestry ought to be the local authority under the rder. The Bill was amended accordingly, and ordered to e reported to their Lordships' House. These propositions ere made to the House of Commons Committee by Mr. oon, chairman of the Electric Lighting Committee, and r. Whitmore, M.P., but rejected. As seen above, Mr. olland succeeded in carrying them through the House of ords Committee.

Gas v. Electricity at Leeds.—Mr. Walter Rowley, M.I.E.E., Meanwood, Leeds, writing to the *Leeds Mercury*, has some very *apropos* remarks upon Mr. Preece's paper last week before the Incorporated Association of Municipal and County Engineers. "Such a statement of facts from the chief electrician to the General Post Office," says Mr. Rowley, "is one that cannot fail to direct the attention of all municipal bodies to the subject, and not allowing such considerations as existing gas works to retard or diminish the adoption of a form of lighting which, on account of its cleanly and sanitary nature, is far preferable to gas. The figures given by Mr. Preece are a remarkable confirmation of the statements made by Alderman Spark when the discussion in the Leeds County Council took place, and we are indebted to him for the very manly way in which he fought for the electric light. Although defeated in their efforts to secure for the town an efficient and cheap electric lighting system, the minority which Alderman Spark represented will before long be shown to have taken the right position. The effect of handing over the lighting of the town to private companies will be that they will only take their systems into the thickly-populated districts, unless compelled to do otherwise; ratepayers in districts farther from the centre of the town, having equal rights to the supply, being left unprovided for. The lighting of a town is one of the duties which ought to be fulfilled with the greatest economy by the local authorities rather than by private ventures. After such a statement as that of Mr. Preece, it must be admitted that electric lighting has now fairly passed out of the experimental into the really practical stage; and, on behalf of those who know the advantages of electric lighting for domestic purposes, this appeal to the authorities is made, and I would ask all to rise above party feeling in this matter, and combine in an effort to secure with as little delay as possible the supply of the electric light to all ratepayers who desire it. The question is one that claims the serious and unbiassed consideration of those upon whom rests the responsibility of supplying (or refusing) a want which all who are intimately acquainted with the subject believe to be a requirement in the public interest. The importance of this matter has induced me to address this letter, in the hope that, even at the eleventh hour, the attention directed to the subject may have the result of making the supply, under existing circumstances, as extensive and complete as possible."

Trial of the Gordon Electric Car.—At Messrs. Merryweather's works, Greenwich, on Tuesday, we had the pleasure of witnessing a trial run of the Gordon closed-conduit electric railway. As it is not improbable that a long section of tramway may be shortly fitted up with this system, it may be worth while drawing the attention of tramway and electrical engineers somewhat forcibly to this system, a paper about which was read by Mr. Gordon himself at the Tramways Institute meeting last week, reproduced elsewhere. A line of tram rails exists at the back of Messrs. Merryweather's works, and this line has been fitted up by Mr. Gordon as an experimental line. A car trolley completely fitted with motor gears and switching apparatus is in actual working order, and seems to behave admirably. The principle adopted by Mr. Gordon is ingenious, and the working out of it not less so. The conduit carrying the current for the motor is a very small one, some 2in. or 3in. of ground being quite sufficient to contain it. The supply rail is laid midway between the two line rails, and consists simply of flat iron laid in concrete in lengths of about 8ft., or one-third the length of the car. The system arranges for charging these sections by the full current of, say, 400 volts, as the car progresses, so that no section is charged except those under the car. This is done by a system of connections laid in a gas-pipe with tee-pieces connecting to each length and leading back to a commutating box, which is the feature of the system. These boxes are placed every 100 yards under the kerb, and contain strong long-pull magnets, one for each section. As the car progresses, a shunt current comes back from the section No. 1 to the magnet No. 2, which rises and puts section No. 2 into connection, cutting off No. 1, and so on, as the car moves—the main, of course, running the entire length of the road. These boxes are of very strong construction, and, as seen on the trial, act with precision and force, being able to withstand rough usage. The current being turned on, the car moved forward at considerable speed, and it is interesting to watch magnet after magnet rise and fall, like the keys of a piano, one after the other with absolute precision and not the least sparking. The pull of the magnet is about 7lb., and evidently is more than ample to do its work. The car was run backwards and forwards by Mr. Gordon, under complete control, nothing more being required than the movement of the car switch, which acts both as resistance and as reverser. The advantages of the system are the use of the closed conduit—no slot or wires that can be touched being needed; the small cost of conduit, and corresponding small cost of alteration of track. Not the least effective advantage of the Gordon system is that, by the addition of one contact, the absolute metallic return for the current can be made by way of the section behind, and thus the difficulty with the telephone companies can be avoided—a matter impossible of arrangement with most systems without costly additions to the mains. The cost of alteration of track and laying the electric conduit is estimated (the figures being checked by Messrs. Merryweather's engineer) as £2,000 per mile, of which £25 each is the cost of commutator boxes. The cost of a new electric car would be £400. Mr. Gordon, allowing all possible contingencies, estimates the actual cost of traction 2½d. per car mile. As to the commutator boxes, our opinion is that these will do their work, and are not in the least more fragile than the commutator bars themselves of the dynamo.

TELEPHONE TRANSMITTER PATENTS.

BY A. R. BENNETT.

No doubt the directors of the National Telephone Company believe that there are good grounds for the warning recently conveyed to the public by their advertisement *re* the Hunnings, Blake, and Crossley transmitters—that those patents are really valid, and that they are performing an act of kindness in cautioning all and sundry against them.

But it does not follow that their advertisement should be accepted without discussion. It would be sorely against the public interest to suffer telephone enterprise to be crippled, and development arrested for another 18 months, simply out of deference to the not altogether disinterested opinions of the National Company's directors. Their duty to the shareholders would require them to put the best complexion on the matter, even though they had their doubts, and it behoves those interested from the opposite point of view to examine their statements and judge for themselves whether they can be substantiated or not.

I have recently had occasion to enquire somewhat narrowly into the actual status of the very three patents mentioned in the advertisement, and I have much pleasure in acceding to the suggestion that I should make public my conclusions and the reasons for them.

In the first place, I consider that the National Company is apparently inclined to attach far too little importance to the labours of our distinguished countryman, Prof. Hughes. A good many months before the date of the first secondary patent Prof. Hughes showed how more efficient telephonic transmitters than any devised by Edison could be constructed out of conducting powders and fragments of charcoal; but inasmuch as Edison was before him with his tension regulator patent (No. 2,909, of 1877), and that patent mentioned variable contacts and carbon in the form of lampblack, it was held that Hughes's discoveries were anticipated and covered by Edison. As a result, the expiry of Edison's patent on July 30th next will not only set free all the forms of transmitters described in it, but also all the forms invented by Prof. Hughes, and will further allow of some of Edison's transmitters being improved into really efficient instruments by the substitution of hard carbon for the plumbago points and semi-conducting tufts originally imagined.

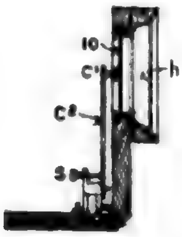


FIG. 1.—10, diaphragm; *h*, mouthpiece; c^2, spring c^1, contacts; *s*, regulating screw.

Edison's specification is a voluminous one, and amongst a mountain of dross contains, comparatively, but few grains of gold. Before proceeding to the examination of the three chief secondary patents, it would be well, therefore, to briefly indicate the chief points he makes, and ascertain what features of value become free in August through the lapse of the Edison rights.

The passages in his specification bearing most on the practical question are as follow:

EDISON (No. 2,909, JULY 30TH, 1877).

A. Page 5, lines 6 to 16.—Description of diaphragm preferably but not necessarily of mica, secured at its edges. Amongst others Edison mentions diaphragms of metal.

B. Page 6, line 5.—"In some cases I make use of a variable resistance resulting from greater or less intimacy of surface contact.

C. Page 6, line 31.—"In some instances I make use of the best quality of lampblack."

D. Page 7, line 15, Fig. 10.—"*h* is a resonant chamber at the end of which is the diaphragm 10, and at each side of this diaphragm there are springs, *C2*, *C3*, having points made up of compressed plumbago. . . . These points face each other on opposite sides of the diaphragm, and make contact with platina disks secured to the diaphragm."

E. Eighth claim is for an adjusting screw or variable presser to regulate the resistance of the tension regulator in the electric circuit.

F. Fig. 24 is a diagram of a microphone and battery in the primary circuit of an induction coil, of which the secondary is to line and earth.

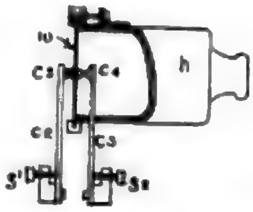
It may be remarked, however, that Edison had no right to claim this combination, since Dr. Wright as far back as 1867 used an induction coil in connection with a Reiss transmitter, and Cromwell Varley afterwards employed it with his musical telephone.

Edison's Fig. 10, which is reproduced, shows a microphone carrying two platinum discs, against which are pressed plumbago points mounted on springs, the pressure between the platinum and the plumbago being regulated by adjusting screws applied at the base of the springs.

The expiry of Edison's patent of July 30 therefore frees:

1. Diaphragms fixed at their edges.
2. Variable resistances resulting from greater or less intimacy of surface contact. This is practically the microphone.
3. Lampblack (soft carbon).
4. Springs for carrying microphonic contacts.
5. Screws for regulating the pressure exerted by the springs.
6. Combination of microphone, battery, and induction coil.

So after July 30 any person will be free to use any or all of these factors, provided he combines them in a manner not effectually protected by subsequent inventors.



EDISON'S FIG. 10.—10, diaphragm; *h*, mouthpiece; c^2, c^3, springs; c^4, c^5, contacts; s^1, s^2, regulating screws.

The discoveries of Hughes already alluded to increase the foregoing free list by the addition of *hard* carbon, multiple surfaces, and conducting matter in the form of powder. It will be permissible to combine or interchange Edison and Hughes's discoveries. With such material at command, the telephone engineer who cannot design an efficient transmitter and still keep clear of Hunnings and Blake, may reasonably be adjudged to have mistaken his vocation.

I shall now submit the secondary patents to some analysis with the view of ascertaining how far they are original, and whether they do not run some risk of being indicted as (to borrow a term from the National Company's advertisement) "colourable imitations."

HUNNINGS (No. 3,647, SEPT. 16TH, 1878).

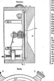
Hunnings's claim is essentially for the use of fine powdered carbon confined in a loose state between two metallic diaphragms, one of which is vibrated by the voice.

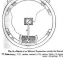
Hunnings preferred thin platinum foil for his vibrating diaphragm, and seemed to consider a metallic or a metal-covered diaphragm indispensable. That is what he foreshadows in his provisional and claims in his final, and there is no suggestion as to the practicability of using diaphragms into the composition of which metal does not enter, except in one place in the final, where, after enumerating platinum, iron, and silver, he adds "or other material." But it is evident that if "material" is not actually a misprint for metal, the other material he had in view must have been metallic in its nature, since no allusion is made to the special contact or electrode that would be necessary were wood or other non-conducting material employed.

Hunnings's own words may be quoted as showing what he believed to be new in his invention. After disclaiming any right to Hughes's microphone and Edison's carbon telephone, he says: "But what *I believe to be new and desire to claim as my invention under the hereinbefore-in-part recited letters patent is*: 1. The use of finely-powdered carbon, *or like conductor* (preferably oven-made engine coke prepared as described) in a loose and free state (not compressed or consolidated in any way or combined with foreign material) as a means of varying the resistance of a telephonic circuit by the vibrations of a thin metallic *or metal-lined* diaphragm enclosing it, controlled by the sound-waves impinging upon it. 2. A telephone transmitter consisting of a layer of finely-divided carbon or similar conducting material, preferably oven-made engine coke, placed in a loose and free state between the thin metallic *or metal covered* diaphragm in a suitable case, and for the purpose described."

Since these claims avowedly cover all that Hunnings believed to be new, and expressly exclude all but metallic or metal-covered diaphragms, it surely would not be complimentary to Hunnings to rule that he meant wooden and carbon diaphragms as well, although he was not aware of it.

Section.





Front.

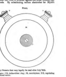


FIG. 2.—Details of an Efficient Transmitter suitable for Secondary Patents that may legally be used after July 30th.
B C, brass clamp; C C, carbon contact; C B, carbon block; D, diaphragm; I R, indiarubber ring; M, mouthpiece; R S, regulating screw; S, spring; T, terminal screw.

The point is of importance, because about nine months later Mary (No. 2,457, June 21, 1879) protected a transmitter of powdered carbon confined between two wooden diaphragms, having carbon discs attached to their centres as contacts. This combination, although invented by Mary, was generally known as the Moseley transmitter. The patent is now void, and if held free of Hunnings, would be open to all after July 30.

Subsequently, Moseley (No. 1,326, January 30, 1880) and Berthon (No. 2,893, March 4, 1880) employed powdered carbon confined between diaphragms of thin carbon plate. Of these, Moseley's has lapsed, but Berthon's is still in force, although its validity in face of Moseley's prior claim for granulated carbon between carbon diaphragms is considerably more than doubtful.

The diaphragm is not the only weak point about Hunnings's, for Hughes, in his paper before the Physical Society (*Nature*, June 27, 1878), stated that he had discovered that a current passing through conducting matter in a divided state, either in the form of powder, filings, or surfaces, was varied under the influence of the slight pressure applied by sonorous vibrations. This specific mention of conducting powder by Hughes four months before Hunnings applied for his patent, precludes the latter from claiming any exclusive right to powdered carbon.

Again, on June 3rd, 1878, three and a half months prior to the date of Hunnings's patent, Prof. Blyth, of Glasgow, described in a paper to the Royal Society of Edinburgh (*Nature*, June 13, 1878), a transmitter consisting of pretty coarse fragments of gas cinders packed in a shallow box of thin wood, having two (tinned iron?) strips at the ends to serve as contacts. The results obtained he described as satisfactory, although there was no front vibrating diaphragm. I have recently had an experimental transmitter made to Blyth's description, and find it is really an efficient instrument. The box speaks equally well, and very well, whether the voice is directed against the sides, bottom, top, or ends. By substituting carbon electrodes for Blyth's tinned ones, and extending them across the box, so as to reduce the intervening space to be bridged by the carbon particles, and by using fragments of proper microphonic carbon in lieu of Blyth's cinders, a transmitter of which no one need be ashamed is formed. The carbon may be much coarser than the powder described by Hunnings, but in view of Hughes's prior publication there can be no risk in using even the finest powder in a wooden box, no part of which partakes more of the nature of a diaphragm than another.

As we have seen that Edison was before Hunnings with metal diaphragms, and Hughes and Blyth were before him with conducting matter in the form of powder and fragments of carbon, the most Hunnings can claim is a combination of the two, and he is, in fact, modest enough to so limit himself.

BLAKE (No. 229, JANUARY 20TH, 1879).

This is the next secondary patent in order of date. Blake's claims are five in number.

Claim 1 is for his method of holding a diaphragm by means of springs.	This need incommode nobody, since a diaphragm fastened at its edges as described by Edison is practically as efficient.
Claim 2 is for a spring carrying one of the microphone contacts, the other contact being carried by a second spring or fixed direct to the diaphragm.	It is difficult, in face of Edison's Fig. 10, to imagine wherein this differs from Edison's plan, which, omitting the superfluous second spring, could be described in the same words.
Claim 3 is for Blake's peculiar form of adjusting lever.	Of course Blake is quite entitled to this. The form of adjusting screw shown by Edison in his Fig. 10 is not a very good one, but others could be devised without infringing Blake's.
Claim 4 is for the combination of two contacts, each carried by a spring.	Edison's plan of one contact on a spring and the other on the diaphragm is practically as good.
Claim 5 is for the addition of a yielding weight to one of the springs, for the purpose of resisting the movement of the diaphragm and of modifying by its inertia the variation of pressure.	This has a strong resemblance to the device described by Hughes to the Physical Society (*Nature*, June 27th, 1878): "The upper contact of a microphone should have its inertia supplemented by a balanced weight. This inertia I find necessary to keep the contact unbroken by powerful vibrations. No spring can supply the required inertia." But such a weight is not really necessary.

In fact, a transmitter made up to Edison's Fig. 10, but with only one spring and one pair of contacts, which could both be of hard carbon in lieu of Edison's plumbago and platinum, speaks at least as well as the Blake, and with such a transmitter, Fig. 2, Blake could not interfere.

It would be unkind to an old acquaintance like Blake to hint anything about "colourable imitations," but there is certainly a family likeness between half of Edison's Fig. 10 (see Fig. 1), and the essential features of the Blake, a similarity accentuated by the coincidence that both inventors use platinum for one of their surfaces.

CROSSLEY (No. 412, FEBRUARY 1ST, 1879).

The last of the secondary patents to which importance is popularly attached is that of Crossley. It is a legal dictum that the contents of the provisional and final specifications of a patent must agree in substance. If they do not, or if matter is introduced into the final that is not foreshadowed in the provisional, then the patent is invalid, or, at least, the matter not so foreshadowed cannot be claimed. With the best intentions in the world, I must confess my inability to detect any novelty in Crossley's provisional or any resemblance between his provisional and final. The provisional is very short, and foreshadows an invention (!) consisting of nothing more nor less than "an ordinary microphone" (Crossley's own words) mounted on a parchment or other suitable diaphragm in conjunction with a battery and induction coil. Reading the provisional by itself, one would imagine that Mr. Crossley had lodged it under the impression that the use of an induction coil with a microphone was novel and with the design of protecting that combination.

But in the final it is stated (page 3, lines 26 to 28 and 56) that the induction coil is not necessary, only desirable. So the coil, not being a necessary part of the invention, must be deleted from the provisional, and then what remains? Nothing more than "an ordinary microphone" mounted on a parchment or other suitable diaphragm. But the process of elimination can be carried further, for in the final "an ordinary microphone" is defined as having only one pencil and two surfaces touching each other, "to which," Mr. Crossley wisely adds, "I lay no claim." Take away this disowned ordinary microphone from the provisional, and what remains? Clearly, a parchment or other suitable diaphragm; an appliance not altogether unknown to Reiss in the early sixties. But in the final, the term "compound microphone" is introduced, and defined as a microphone having three, four, or more pencils, and six, eight, or more surfaces touching each other. The figures show compound microphones of Crossley's well-known form; but the claim is not for this form alone, but broadly for microphones having three, four, or more pencils, and six, eight, or more surfaces. Putting aside for the moment the want of agreement between the provisional and the final, I do not see how such a claim can be sustained; for Hughes, in his paper to the Physical Society, June 8, 1878 (*Nature*, June 27, 1878), nearly eight months prior to Crossley's patent, said: "A man's voice requires four surfaces of pine charcoal, six of willow, eight of boxwood, and ten of gas carbon." In another paper (*Nature*, May 16, 1878) Hughes said: "The effect was improved by building up the nails, log-hut fashion, into a square configuration, using 10 or 20 nails. A piece of steel watch chain acted well." Mr. F. J. M. Page, in a letter to *Nature*, May 30, 1878, speaks of three pieces of gas carbon in circuit with the primary of an induction coil and a Daniell cell.

These instances (and I could adduce others) of prior publication respecting multiple contacts are sufficient to destroy any particular claim to such contacts on Crossley's part. Even when arranged in his own special and highly meritorious form, the want of novelty in his provisional, and the startling disagreement between the provisional and final, would render interference on his part hopeless. Beyond all this, it should be borne in mind that an efficient transmitter can be made with only two pencils and four surfaces, and to this, in any form, Crossley could not even pretend a claim.

Mr. Crossley may, however, truly retort that although his patent may not have been drafted by a committee of Queen's counsel and patent agents, it was nevertheless very much to the purpose, since the innocent United Telephone Company gave him £17,500 for it! Crossley can certainly claim the laugh, if nothing else.

To sum up, for the reasons set forth, I believe that the following transmitters may legally be used after July 30:

1. All forms described by Edison in his No. 2,909, substituting, if desired, hard carbon for plumbago, platinum, etc.
2. A transmitter, resembling Blake's in general form, but with diaphragm secured round its edges, with one contact fixed on the diaphragm and with some form of adjusting lever other than Blake's, being practically Edison's Fig. 10. The details of such a transmitter, which contains nothing that was not anticipated by Edison, except the hard carbon contacts, which were anticipated by Hughes, are shown in Fig. 2.
3. All forms described by Hughes in his various papers.
4. Crossley's and analogous forms.
5. Blyth's.
6. Berliner's (No. 1,786, of 1884). A good transmitter, having contacts kept in position by gravity alone. Patent has lapsed.

Of these, Nos. 1, 2, 3, 5, and 6 could not be challenged without the challengers laying themselves open to an action for vexatious interference. No. 4 is safe for those who are not to be frightened by bluff, since there was absolutely no novelty of any description in Crossley's provisional, and his final claims something else. The following three would probably have to be defended if used, for, in spite of Hunnings having claimed only metallic or metal-covered diaphragms for his combination, they might be held as mere variations for the purposes of evasion:

7. Marr's. 8. Moseley's. 9. Berthon's.

The specialities that cannot under any circumstances be ed are :

Until September 17, 1892 : Powdered carbon in combina n **with** a metallic or metal-covered diaphragm. **Until** nuary 21, 1893 : Blake's method of holding diaphragm **springs** ; Blake's special form of adjusting lever ; and **lake's** combination of two contacts mounted on separate **rings**, being respectively Blake's claims Nos. 1, 3, and 4.

LIGHTING OF THE S.S. "SCOT."

The following details of the s.s. "Scot's" electric instal ation will be interesting. There are 680 lamps of 16 c.p., nd 10 electric fans. Two of these latter are Blackman fans driven by Crocker-Wheeler motors, and are used for extracting the foul air from the engine-room skylight. Of the other eight, which are made by Messrs. King, Brown, and Co., Edinburgh, two are downcast and supply air to the engine-room, the remainder exhaust the foul air from the cabins, etc. Current is supplied by three dynamos, by King, Brown, and Co., capable of giving about 200 amperes at 100 volts, driven direct by three compound engines, by Brown Bros., Edinburgh, at a speed of 200 revolutions per minute. Each dynamo has a tachometer attached, and the potential is measured by Sir Wm. Thomson's marine voltmeter. In the dynamo-room there is a main switchboard, Fig. 1, designed by Mr. Malcolm, Sutherland, and made in the electrical department of the Leven Shipyard, Dumbarton. It is 6ft. by 3ft., and is made of white marble steeped in paraffin. The lower part is occupied by three angle bars, which run from end to end, and to each of which a dynamo is connected through a fuse and ammeter clip. The upper portion is occupied by two rows of fuses and two-way switches, to which the fan leads and 14 main leads are attached. As has already been said, the switches are two-way, and to each of them two flexible electrodes are attached, one on each side, having clips on their ends by means of which they may be attached to any of the three bars. As each switch has two electrodes, one of which must always be idle, when it is necessary to change any circuit from one dynamo to another, the idle electrode is clipped on to the dynamo wanted and the switch reversed. In this way any circuit can be changed from one dynamo to another without interrupting the light. By means of the ammeter clips the current can be measured at any time by either of the two Siemens ammeters which have been mounted on the board. From this board the mains are led to 14 distributing-boards, also made in the shipyard works, placed in different parts of the ship. These boards contain switches and fuses, from each of which a wire is run to a group of lamps, the maximum number of which is eight. As the sectional area of the wire is kept uniform throughout, it is unnecessary to have any other fuses. Single wiring is used, except in the vicinity of the compass, where double wires are run ; and to simplify the wiring, and make testing and repairs easier, soldered joints are superseded by a patent screwed junction made by W. McGeoch and Company, Glasgow, as shown in Fig. 2. This consists of a small brass pan about an inch in diameter over all, screw threaded inside, and with vertical slots cut in the sides. This is mounted on a slate base, and placed inside of a metal watertight junction-box, on the sides of which are small stuffing-boxes. To join two or more wires together, they are brought through the stuffing-boxes. The insulation is then removed, and the bare ends inserted through the slots and coiled up inside the junction pan. A soft tin washer is then laid on top of them, and a brass

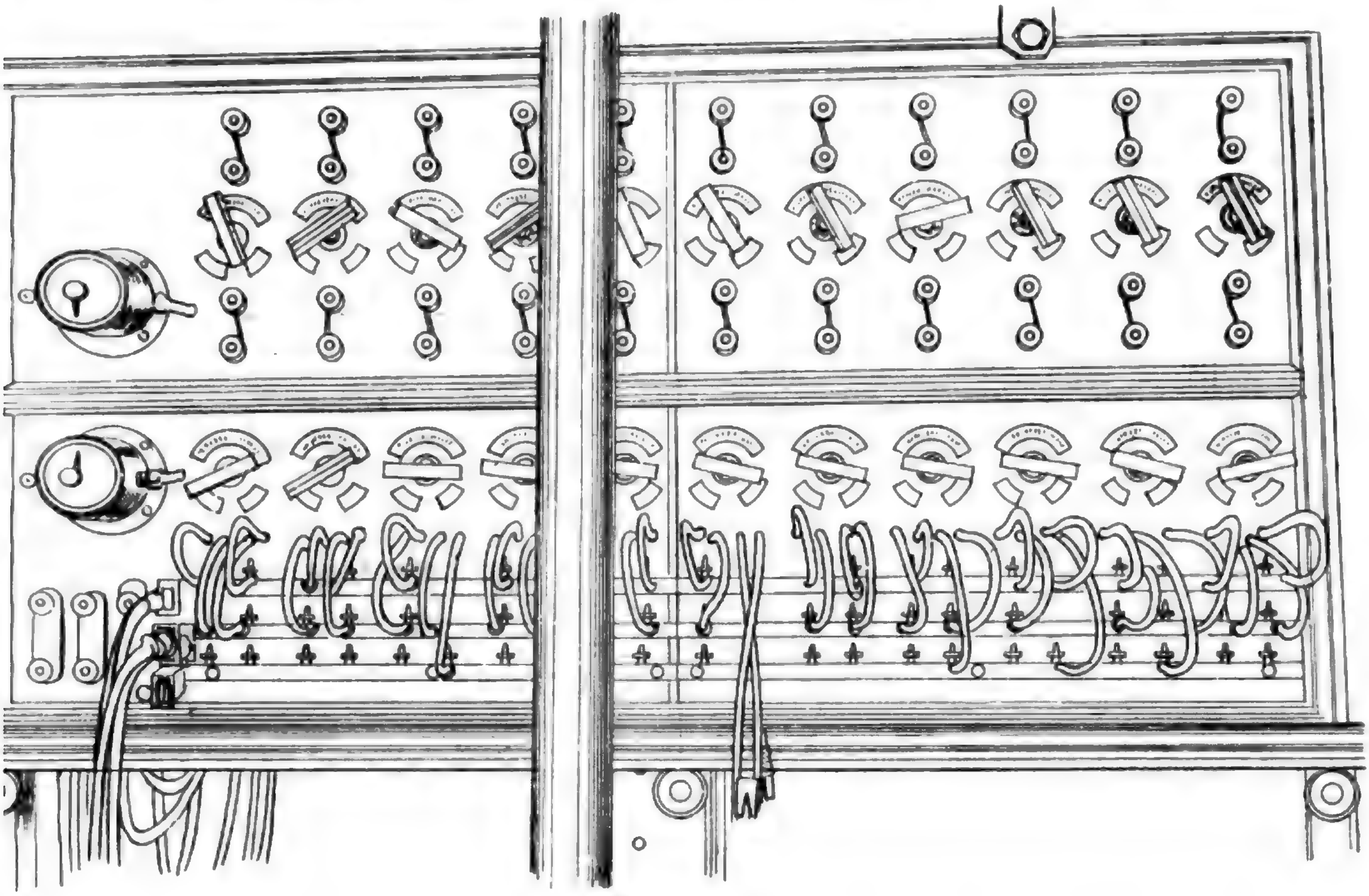


Fig. 1.

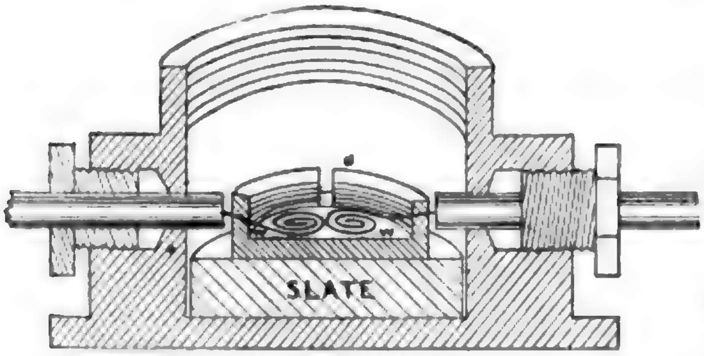


Fig. 2.

button is screwed hard up on them. As the diameter of the screw is very large compared with its length there is no fear of it coming loose, and the surface of wire used in the joint being large, there is no heating. A very good joint is thus obtained without the trouble and danger of carrying heated bolts or blow-lamps about. It is also much easier to disconnect portions of any circuit when searching for a fault which may have occurred. One of these boxes is used for each lamp, the stalk of the lamp being screwed through the cover of the box and forming the return, the current being carried to the lamp by an insulated metal rod in the centre, at the upper end of which is a spring contact which presses against the button of the junction. All joints in the small wires are made inside of junction-boxes, and there are no joints in the main cables. All the wires are of high insulation, the mains being Silvertown vulcanised rubber, lead-covered, and taped. Most of the small lamps are wired with vulcanised rubber-covered wire, made by the International Okonite Company, and the remainder, comprising the engine-room, stokehole, deck lights, etc., are wired with Fowler-Waring lead-covered armoured wire.

TELEPHONE TRANSMITTERS.

A short time ago, having occasion to call upon Mr. Lewis, the genial manager of the Western Counties and South Wales Telephone Company, we noticed a diagram indicating the various forms in which carbon has been used in transmitters. Mr. Lewis very kindly acceded to our request, and by his courtesy we are enabled to give the accompanying illustrations. Fig. 1 shows one of the well-known forms introduced by Prof. Hughes. Fig. 2 and 2a show Edison's carbon button or disc, as used in his transmitter, patented July, 1877, No. 2,909. Fig. 3, also Edison's, shows lampblack of the best quality, used in a transmitter. This was patented in July, 1877. Edison also uses finely-divided carbon, as does Hunnings, Fig. 4, patented September, 1878. In the Edison's, the divided carbon is between two discs; in the

FIG. 1.

Carbon Button or Disc.

FIG. 2.

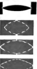
FIG. 2a.

FIG. 3.

FIG. 4.

FIG. 5.

FIG. 6.



FIGS. 7, 8, 9, and 10.

FIG. 11.

Hunnings's disc between two discs, one of which joins the diaphragm. Fig. 5 shows Crossley's arrangement of pencil transmitter, patented in February, 1879. Fig. 6 shows another form, patented in February, 1879, by Crossley, while Fig. 7 shows the Hughes pencil of May, 1878.

Fig. 12.

Fig. 13.

Fig. 14.

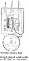
Fig. 15.

Figs. 8, 9, and 10 show other forms of transmitter, used under various names, and Fig. 11, the cup-and-ball microphone; Fig. 12, short pencil microphone; Figs. 13 and 14, other forms of cup-and-ball microphone; Fig. 15, Edison's carbon button slightly modified.

THE TOWNLEY PATENT AUTOMATIC MAKE AND BREAK CIRCUIT ELECTRIC BELL.

This bell is being introduced by Mr. E. Townley. From the claims made by the inventor, Mr. J. Townley, it bids fair to supersede the old form. Having little tension in the spring carrying the armature, it requires less battery power; having the magnetism retained in the armature until it does work, allows longer stroke and a more agreeable tone. It has sliding contacts, making it less liable for these to oxidise; it has an automatic make and break circuit; and the cost does not exceed that of the ordinary form.

Its description is as follows: The circuit is completed in the ordinary way by means of a push. The current passing through the terminal T on to the contact pin, P, along the bell crank, C, through the coves and out through terminal T² to the battery. The usual magnetic field is produced, the armature is attracted, carrying with it the adjusting pin, P², and the ratchet pawl, R, which actuates the wheel, while the adjusting pin, P², moves the bell crank, C, lifts one end from the contact pin, P, thus breaking the circuit, and allows the armature to attain its normal position, but during this movement a second bell



Townley's Electric Bell.

crank, C², is released and allowed to fall on the contact pin, P¹, by means of a pin, P³, fixed on the wheel. The circuit is then allowed to take another direction out through terminal T³, and on to the battery, this circuit being completed until the wheel makes one revolution, when again the pin on the wheel lifts the bell crank C², thus breaking automatically the circuit and allows the armature to come to a state of rest.

The Duplex Alarm.

This alarm is being introduced in conjunction with the Townley patent electric bell. The two may be used together or separate. The clock being portable may be used independently, can be set to ring, and will continue for about two hours if not stopped. Switches and all other complicated parts are entirely obviated.

Townley's Duplex Alarm.

The box, B, contains the battery, on the front of which is fixed the bell. Set the set hand of the clock to the time the alarm is required. Should it be desired to use the two together, simply wind the clock in the ordinary way, but this is immaterial; place the legs of the clock, L and L², on the contacts, P and P², and when the hands of the clock agree with the set hand, the lever which releases the hammer of the clock makes contact simultaneously with a spring which is fixed, but insulated, on the frame of the clock, from which is taken a wire, and led to the insulated leg, L², on to the battery through cover and contacts of the bell, return to battery through leg, L, to where contact was made; the circuit being thus completed, rings the bell until the clock is moved off the contacts, P and P².

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CAMBRIDGE.

It is with considerable hesitation we refer to this question again. The report of the proceedings of the Council, as given in our last issue, is sufficient to prove that all we have previously said upon the matter was warranted. Even now we do not believe the last has been said, and many a keen sportsman would lay long odds against the present scheme being carried out. Surely the suggestion of one member of the Council is possible—to have an authentic account of the working cost of the proposed engines as against an estimated cost from experimental runs. Engineers have somehow contrived to become impressed with the opinion that the engine is a *leetle* extravagant in eating steam. When we had occasion to test the engine as it was made two or three years ago, that opinion was confirmed by facts. At present we are told that improvements have been made, and the engine is to be economical. Of course that may be so, and we must wait events to prove whether it is or is not. We are ready to support the use of these engines in many cases, but as yet not for central stations. Even if initial expense is considered, we are creditably informed that the highest class of low-speed condensing engines, and all the electrical paraphernalia, were tendered for at something like £2,000 lower price. Unless, then, the Council get proof positive as to maintenance economy, we do not well see how the scheme can be carried out with satisfaction.

ELECTRICITY IN TRAMWAY WORK.

The meeting of the Tramways Institute last week was principally occupied with reading and discussing papers on the application of electricity to tramway work. It was a misfortune that these papers related principally to systems not yet largely adopted, or rather only in the experimental stage, and not yet applied in everyday work upon a scale sufficiently large to obtain trustworthy figures and convince the tramway engineers. The practical outcome of each discussion was the same. The engineers said in effect: "We are ready and willing to employ electricity, but before doing so must be satisfied that it will pay. It cannot be supposed that we can give up horse traction, the expenses and the returns of which are fully known to us, for an ideal system about which the figures are most vague, nor can it be supposed that we shall experiment to find out the result." To introduce a new system means new capital. In England the tramway mileage is not likely to greatly increase—in fact, during the past year there has been a slight decrease. Thus the use of electric traction in England means its use upon existing lines, upon which capital account has long since been closed, and to reopen it is not an easy matter. People, however, are willing to speculate if it can be shown there will be a good return for their money, and the only inducement to tramway shareholders to increase their capital is to hold out satisfactory hopes of increased dividends upon the larger capital.

Lineff system and the Jarman system are well wn to our readers, but the Gordon system is less l known. We have therefore requested the author to us an estimate of the cost and the returns of a to be altered from horse traction to electric ction upon his system. Experimentally, the line has constructed at Messrs. Merryweather's is a cess. It has been tested under stringent conditions, and acted well even when saturated with water covered with mud. The figures of the following imate must be considered with care, and it would well if rival systems would give similar estimates. any rate, we should then get a basis for calculan, and the various items could be compared:

TIMATE OF THE CAPITAL COST OF APPLYING THE GORDON SYSTEM OF ELECTRIC TRACTION TO AN EXISTING TRAMWAY, AND THE WORKING COST PER CAR MILE.

Line 3 miles long, double track (6 miles); generating tion as central as possible; five minutes' service at siest time; average speed seven miles per hour, including ppages; cars to accommodate 40 passengers each; aximum number of cars running at one time, 10; .p. per car, 10; total e.h.p. at station (50 per cent. serve), 180.

Permanent Way.	
ltering existing track to suit Gordon system, six miles at £2,000 per mile	£12,000
Rolling-Stock.	
itting 14 cars with motors, gearing switches, etc., (four cars in reserve), 14 at £150 each	2,100
Central Station.	
hree sets of steam dynamos, boilers complete, each capable of developing 60 e.h.p. (one set in reserve), buildings, foundations, switchboard, cables, instruments, etc.	5,400
	£19,500
ess stud of 100 horses and harness, at £35 each	3,500
Increased capital	£16,000
Running Expenses.	
Vages at central station	£364
Vorking electrician	156
uel	854
Vater, oil, waste, etc.	120
Depreciation and Repairs.	
/3 generating plant at 5 per cent.	£150
earing, etc., on cars, 40 per cent.	108
lotors, 25 per cent.	250
rack, 7 per cent.	840
uildings at 2½ per cent.	10
ontingencies, say	250
	£3,102

llowing an average of 80 miles per car per day, the total umber of car miles per annum = 80 × 10 × 365 = 292,000.

$$\frac{\pounds 3,102}{292,000} = 2{\cdot}55\text{d. per car mile.}$$

Horse traction costs about 6d. per car mile = £7,300

Saving by electric traction £4,198, giving a dividend on ncreased capital of £16,000 of 26 per cent.

Taking the present capital at	£35,000
Increase of capital	16,000
Total	£51,000

On which the saving by electric traction of £4,198 would give a dividend in addition to that now paid of 8 per cent.

TELEPHONES.

At the end of this month there will be a general shake up and awakening in the telephone world. Everybody is anxious to know the exact position of affairs. We have in this issue endeavoured to put the whole matter straight, to show what patents expire, to show what patents are still alive and controlled, and to estimate the value of such control. Practically, the conclusions of the well-known authority who has carried out this investigation on our behalf is that telephony will be released from its trammels. With the exception of a few unimportant details, which are still secured by patents, and outside of which excellent transmitters can be made, the world can make free use of the acquired knowledge in telephony. We are glad this is so, for in our opinion no monopoly has ever been worked less creditably than this of the telephone. Years ago we hinted that those most deeply interested in the company-mongering part of the business, would be found at the time of the expiration of the patents to have made hay while the sun shone, and have left the affair with pockets well lined, but with none, or very few, shares to their names. Of course, from one point of view, their action was and is amply justified. They started to make money. They made it. From our point of view we require a good telephone system, and a good service, at a reasonable rate. The shareholders deserve a moderate return for their investment, but the paying public do not wish to contribute to watered capital, watered for the purposes of company promotion and Stock Exchange transactions. That in London, at any rate, there is neither a good system nor a good service, will be gathered from the fact that so late as June 10 this year a circular, issued from the "London Chamber of Commerce," invites the combination of telephone users to obtain "increased efficiency and a reduction in rental." The circular states that "dissatisfaction has long been felt by many subscribers to the telephone company in London," etc. This company, instead of moving heaven and earth to please its customers, is finicking with advertisements cautioning people that it still controls various patents. No one need be frightened by this game of bluff. It is an ingenuous attempt to presume upon the ignorance of mankind. The stake, however, is too valuable for the whole question not to have been thoroughly investigated. It may be assumed also that by this time the Government knows its mind, and realises that unless the existing companies—as some of them undeniably do—give an efficient and fairly cheap service, it must undertake the duties and the responsibilities of its telegraphic monopoly.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

BATH.

SIR,—Having seen Mr. Hooker's letter in your last issue with reference to the Bath central station, I beg to say that up to the 30th January no alterations of any moment had been made by me; and that therefore any credit due for the state of the station at that time is due to him.

Had I seen your issue of 30th January, I should have corrected your statement at the time, Mr. Hooker having done all that lay in his power to hand over the station in good running order.—Yours, etc., MARTIN C. OLSSON.

Bath, July 5, 1891.

JAN VAN BEERS AT THE CONTINENTAL GALLERY.

Something very choice and dainty and artistic took place in the small hours of Wednesday night, in the shape of a "souper artistique," by M. Jan Van Beers, as a "welcome" to his friends and patrons in England, and the function was carried out in a way that will make it long linger in the memories of those who were invited. M. Jan Van Beers is a most clever, daring, and original artist, whose realistic and skilful effects place him as a kind of successor to M. Wiertz, of Brussels fame, and his finish and delicacy almost rank him as a second Meissonier. His undeniably humorous and fetching little picture, "My Friend, Mr. White," recently reproduced, gives an idea of the *verve* and interest he manages to put into his pictures. Something of the same kind of effect was embodied in actuality in his supper at the Continental Gallery, 157, Bond-street, and as this effect was largely due to the skilful use of electric light, this otherwise exclusively artistic gathering comes within our scope. Over a hundred guests sat down at the somewhat fanciful hour of half-past eleven, among the guests being the Duke of Marlborough, Lord Dorchester, the Marquis de Stacpoole, Mr. Aird and Signor Tosti, Mr. Alma Tadema, Mr. Thaddeus (the painter of Mr. Gladstone's portrait), Captain Annesley, Mr. Spielman (of *Black and White*), Mr. Harry Furniss, Mr. Clement Scott, and a large number of other celebrities. The Prince of Wales was expected to look in, but his engagements with the German Emperor prevented. M. Van Beers had designed and superintended the arrangements himself. The long dining-table—upon which looked down his enchanting little pictures—was strewn with a long garland of roses, and similar wreaths festooned the walls and ceiling, amongst which electric lights were hidden within white, golden, and pink artificial roses. The table itself, most artistically laid out, was of glass, covered with a fine damask tablecloth, and all along the under side were arranged some 300 incandescent lamps of various colours—white, yellow, green, and rose—which lit the table from underneath and suffused the whole with a glow as of a veritable fairy palace. Madame Melba, from the Opera, first sang, her voice sounding from behind the tapestry curtain. Miss Florence St. John afterwards sang a strangely pathetic ballad after the supper had commenced. The first dish was a fancy from "Sing a Song of Sixpence," and M. Jan Van Beers opened a "Nightingale Pie"—not a ogrish repast, but one that set free a host of little songsters, who fluttered about and sang at intervals the rest of the evening. After which, the supper proper—with its "saumon à la Française, zephirs de Volvaille, chautroix d'Ortolans, salade Byzantine, Nougat Chantilly, Pommery Greno," etc., with the fruit served in glittering dishes, around which tiny lamps glowed and twinkled. All the while, at intervals, the lamps changed, the table glowed up like the dawn from pale pink to pure white, and died away again; changeful effects innumerable succeeding each other continually, interspersed with violin and 'cello solos by M. Hollman and M. Van der Straten, as well as delicate concerted pieces. Presently the white ceiling became suddenly illuminated, and a series of political cartoons from *Vanity Fair* and elsewhere were projected with most amusing effect, stretching down the ceiling. Mr. Aird made a little speech, thanking M. Van Beers for his entertainment, and M. Van Beers himself, speaking in English, hoped his friends and patrons had enjoyed his "*petite fête*," and trusted next year to welcome the ladies as well. It only remains to add to this account of a remarkably successful entertainment that the electric installation for the gallery, consisting of 575 incandescent lamps, was fitted up by Messrs. C. Mellier and Co., artistic decorators, of 48-50, Margaret-street, Cavendish-square, under the superintendence of Mr. W. Lowry, their engineer, who carried out the unique task of fitting up the whole in one day with four men, setting up the transformer also, which provided the current from the Grosvenor circuit.

TRAMWAY COMPANIES AND ELECTRIC TRACTION.

Whilst electric tramways, or, as they are more generally termed, electric roads, have been largely developed in the United States, in England nothing beyond experimental work has as yet been done in this direction. The great difficulty has been to induce the directors of English tramway companies to take an interest in modern systems of propulsion. The first time that the subject of electric traction was brought prominently under the notice of the tramway companies in this country was on the occasion of the annual meeting, which took place a year ago, of the Tramways Institute of Great Britain and Ireland—a society to which belong nearly all the tramway companies in the United Kingdom. At that time the interest manifested in the subject was not very great, but it was intimated that more consideration would be given to the matter at the next assembly of the institute. The meeting in question took place at the Westminster Palace Hotel on the 2nd inst. Mr. W. J. Carruthers-Wain, managing director of the Birmingham Central Tramways Company, etc., presided over the meeting, which was well attended. The chief point of interest was centred in the reading and discussion of papers treating of the employment of electricity as the motive power of English tramways. The papers read were on "The Lineff System of Electric Traction," by Mr. Gisbert Kapp; "Self-contained Electric Tramcars," by Mr. A. J. Jarman; and "The Gordon System of Electric Traction," by Mr. J. Gordon. Throughout the whole of the proceedings the tone of the tramway men in conference was favourable to the use of electricity, provided that agency could be shown to be economical; and the result of the assembly, which will probably mark an era in the development of modern systems of locomotion, was the offer on the part of several tramway directors to allow of experiments to be conducted with electric tramcars on their lines for a sufficiently long period to demonstrate the practicability and commercial prospects of any particular system. Should the results be favourable, the companies were prepared to adopt electricity as the means of traction.

Before the reading of the first paper was commenced, the president referred to the action of the National Telephone Company on the occasion of the Birmingham Central Tramways Company's seeking to get confirmed by Parliament its provisional order authorising it to use electric traction. This matter was dealt with in our leading columns last week, and the chairman stated that unless the decision of the House of Lords Committee on the point of the complete metallic circuit were reversed, another obstacle would arise to retard the progress of electric traction.

In the course of his paper on the Lineff system, Mr. Kapp referred to an improvement which had been effected in the underground conductor, and by means of which the insulation resistance of the line had been greatly augmented. Originally the conductor touched the bottom of the channel throughout its whole length; the improvement consisted in the use of a copper trough as the conductor, and supported at intervals on insulators. This method had increased the insulation from 4,475 ohms per mile, to an average of 35,000 ohms, and he believed that even this could be still further augmented. Moreover, by the provision of boxes at suitable intervals, the iron strip could be withdrawn for renewal or cleaning without disturbing the surface of the street.

During the discussion Mr. Sturgeon, of Chester, said that he doubted the practicability of the Lineff system owing to the lack of a solid connection between the sectional rail and the car. He thought there must be a great loss of power in slowing down or stopping the car.

Mr. A. Dickinson, of Darlaston, was of opinion that it would not be possible to prevent water and dirt from getting to the conductor, and that if water in sufficient quantity collected in the conduit, a great loss of current

.d take place through its forming a conducting means he earth. In Boston, where a conduit 3ft. deep had used, it was found impossible to keep out moisture and This caused such a great leakage that the system to be abandoned, and he did not think that in the ff system, with a smaller conduit, that difficulty could vercome.

r. A. Reckenzaun, after referring to commercially essful electric tramways on the Continent, said that considered the insulation tests on the short line at wick were practically valueless. If the Lineff system laid down in a street where heavy traffic prevailed, opined that the passage of heavy carts would disturb conductor, and perhaps crack the insulating channel. er might then enter and seriously damage the insulation.

r. W. J. Carruthers-Wain said that in the United es electricity as the motive power was advantageous to the tramway companies and the travelling public, that many companies were transforming their lines electric tramways. The cost per car mile of working able line in the States was 6·77d.; an electric road, d.; and a horse line, 8·71 per mile run; thus showing avour of electricity. He asked for particulars regarding initial cost of the generating plant for the Lineff em, and the estimated cost of working. Referring to storage battery cars in Birmingham, as the year's king had only just been concluded, he was not in a tion to state the operating cost. The introduction of se cars had, however, had a remarkable effect notwithding the difficulty of the track being bad on that ticular line. During the year ending June 1889, with se cars, the number of miles run was 134,000; the l receipts, £6,338; and the receipts per car mile, 3d. In 1890, when the line was worked by horse and omnibuses, the mileage attained was 136,000, receipts, £5,264; and per car mile, 9·29d. In the year terminated, with storage battery cars, the number of es run was 148,000; the receipts, £8,949; and per car e, 14·46d.

fter Mr. Kapp had replied to the discussion, Mr. Jarman d a paper on his system of accumulator traction, which described in our issue of the 10th October, 1890. Mr. man exhibited his improved storage battery, which was described in a previous issue. The alloying of aluminium h lead in the plates of this cell stiffens the plate and reases the capacity of the negative plate to absorb and ain hydrogen. The author stated that he had not found plates buckle at any time when discharging up to 300 peres, and he believed that the cells would bear at least f as many more discharges as those now in use before renewal of the positive plates was necessary. He ted that accumulator cars could be operated so as to npete advantageously with horse traction. In this nection, the consumption of fuel, wear and tear of chinery, and renewal of batteries on the system was imated not to exceed 2d. per car mile.

Mr. W. Mason, of Bradford, said that accumulator cars y would be successful. The great thing was, "what can u do it at, and will it pay?" He wanted a more nomical method of traction than that by horses, and y would all be happy to substitute electricity if it were ter.

Mr. G. P. Bradford, of the North Staffordshire Tramways mpany, said they wanted a system to improve upon am locomotion. He would be pleased to allow experints to be made on his tramway. What they required s practical proof of the commercial prospects of electric ction.

Mr. Scott-Russell referred to accumulator traction nerally, and stated that all trials made hitherto had been lures from a financial standpoint. He, however, believed the accumulator system for this country, and said that e cost of working the Barking cars was 7d. per car mile, d of those in Birmingham 10d. per car mile. Unless Mr. rman could show that his car could be operated within lf that figure, he feared that the system would be no re successful than previous methods.

Mr. Carruthers-Wain said what they all required was the sult of practical work on a reasonably long line and tended over a considerable period; experimental runs on short lines or occasional trips on long lines were not of much value. In addition to the offer made by Mr. G. P. Bradford, he (the speaker) and Mr. A. P. Smith, of Manchester, were prepared to allow of experiments being conducted on their tramways. He had in mind several lines where any system would be welcomed, provided electrical engineers would profess their belief and stand or fall by it. Although he was the managing director of the Birmingham Central Tramways Company, he had as yet been unable to ascertain the cost of working, and it was a mystery to him how Mr. Scott-Russell obtained the figure mentioned.

Mr. Jarman having replied to the discussion, Mr. J. Gordon read a paper describing his system, which has not previously been described at any length. We therefore give this paper:

THE GORDON (CLOSED CULVERT) SYSTEM OF ELECTRIC TRACTION, AND DETAILS OF EXPERIMENTS AT MERRYWEATHER AND SONS' TRAMWAY WORKS, GREENWICH, S.E.

Almost since the introduction of street tramways the general desire of engineers and managers has been to replace animal by some kind of mechanical traction. Both the steam engine and the cable have had a fair trial. As is well known, the steam tramway is fast becoming a thing of the past, and it is admitted by even the strongest supporters of the system that cable haulage is more economical than other systems only on short lines with steep gradients. There is no limit to the steepness of line which a cable car can climb, but on long lines, with only moderate gradients, the advantage possessed by the cable system disappears on account of the large amount of power required to keep the cable itself in motion, this power being, of course, waste. There is thus a most promising field open for the application of electricity to the propulsion of tramcars.

The electrical engineer who tackles this problem to-day has a much easier task before him than the pioneers in this work had a few years ago. He can go to the open market and purchase dynamo machinery which is practically perfect, as well as excellent and reliable electromotors. No doubt a slow-speed motor, the armature of which could be keyed directly on to the axle, and which would not be too heavy, is highly desirable; but the use of noiseless speed reducing gearing overcomes this want in a perfect satisfactory manner.

Seeing, then, that the electric current can be so efficiently produced at the power depot, and again transformed into mechanical power on the car, it seems strange that electric traction on tramways has made in this country so little progress. The difficulty lies, or has lain, in the means of conveying the electric current generated by the dynamo at the depot to the electromotor carried by the car. The method by which this is to be effected must not be too costly to install, must be efficient in working, and not liable to break down, must offer no obstruction or inconvenience to the general traffic, and, even if currents of low potential be used, there must be no possibility of persons or animals—especially horses—coming into contact with a charged conductor. Moreover, the installation must not be liable to objections on æsthetic grounds.

There are four well-known methods of conveying the electrical energy from the central station to the motor or the car.

The Storage System.—In this system the electrical energy generated at the station is there supplied to electric accumulators or storage batteries, and these, when fully charged, are placed on the car, and supply to the motor the current required. This system possesses the great advantage that it can be applied to existing tramways without any alteration in the permanent way, provided the latter has been built sufficiently strong to stand the great weight of these cars and the increased wear and tear.

Unfortunately, however, the system is very costly both to install and in running expenses. The highest technical skill, backed by almost unlimited money supplies, has been employed on the subject for years, and although very great improvements have been made, and a very excellent battery for stationary work produced, we are still without a satisfactory battery for tramway work, and until one has been evolved much more nearly fulfilling the necessary requirements, traction by means of accumulators cannot, from a commercial point of view, compete with horses.

Overhead System.—In this system bare conductors are led overhead from the central station along the whole length of the track, and connection is made between this and the motor on the car by means of a pole attached to the roof of the car by means of a sort of universal joint, and carrying at its upper end a collector which rolls on the under surface of the overhead conductor as the car moves along. Both from an engineering and a commercial point of view this system is the best of all, but, taking other considerations into account, it has serious drawbacks. The unsightly poles and cross-arms erected along the street are an eyesore and inconvenience to the public, and all the objections against overhead telegraph and telephone lines apply with much greater force to overhead tramway lines, and the breaking of a conductor in a crowded street might be attended with fatal accidents.

In America numerous lines of considerable mileage have been installed on this system, involving an enormous amount of capital, simply because it was the best system available. The results from a commercial and engineering point of view are very satisfactory, but even in America an outcry is already being raised against the poles and overhead wires.

It may be taken as a foregone conclusion that neither in Great Britain, nor in most of the principal continental towns, will the overhead system ever be tolerated.

Open Culvert System.—This system has produced most excellent results, but is very costly to install. It involves digging up the concrete foundation to a considerable depth, and almost rebuilding the tramway. Moreover, the open slot along the whole length of the track through which connection is established between the conductor and the motor is decidedly objectionable, and is also a source of danger to cyclists.

Closed Culvert System.—In this system a surface conductor is formed of a series of short lengths of mechanically strong conductor, fairly well insulated from one another, usually running along midway between the permanent way rails, and with their upper surfaces flush with the roadway. Underneath is a closed culvert containing a well-insulated main conductor leading from the central station, but the short lengths of surface conductor are electrically connected with the main conductor only when covered by a passing car.

This system is most promising of all, and inventors have been working at the subject for the last 10 years, but so far as I am aware, no surface conductor system has yet come into use. The difficulty lies, has lain, in the means of electrically connecting the various short surface conductors with the main conductor communicating with the source of supply at the moment a car is passing over the former, and disconnecting them immediately the car has passed. Various methods have been proposed to effect this, such as by means of a small motor trolley running within the culvert and keeping pace with the car, by attracting a strip of magnetic metal by means of an electromagnet carried by the car so as to short-circuit the main conductor with the surface conductors covered by the car, or by mechanically or electrically actuated switches which put the various short lengths of surface conductor into electrical connection with the main conductor at the moment when the former is covered by a car. I do not propose to discuss the merits and demerits of the various plans proposed to solve the problem involved in this system. My object is to bring before your notice a new method of working this system, which solves all the difficulties and meets all the requirements mentioned above.

The Gordon Closed Culvert System.—This is an improved surface conductor system, the improvements being chiefly in the means of establishing and breaking connection between the main conductor and the surface conductors, in simplification of the closed culvert, and in dispensing with all moving parts under the roadway. Extensive experiments on this system have been carried out during the past 12 months on a full gauge line at Messrs. Merryweather and Sons' engine and tramway works, Greenwich, S.E., with the most satisfactory and encouraging results. In the Gordon system, instead of using a complicated automatic mechanism for each short length of service conductor, a number of such conductors are grouped into a section, and one electromatic switch or distributor works the whole group. As the surface conductors are about 8ft. or 9ft. long, and 30 or thereabouts are grouped into a section, the distributors are few in number—about 20 per mile—and spaced about 90 yards apart. They may therefore be placed advantageously in boxes under the pavement, immediately inside the kerbstone, and the conductors may be tested, withdrawn, and replaced with little or no disturbance to the traffic. The culvert is the simplest imaginable, being an ordinary 2¼in. gas-pipe, with T-pieces every 16ft. or 18ft.—that is, opposite every alternative break in the surface conductor. At or about the centre of each group of surface conductors this longitudinal pipe is fitted with a small T-shaped junction-box, from which a cross pipe leads to the distributor-box under the pavement. The top of this T-shaped junction-box is movable, to facilitate the drawing in and out of conductors. The main well-insulated conductor is placed in a longitudinal pipe along the length of the track, and from it a branch is led to each distributor-box through the cross pipes. The openings in the T-pieces in the longitudinal pipe are plugged, and through the plugs are led well-insulated service leads, one from each short length of surface conductor to the distributor, which operates the section of which it forms an element. It might at first strike one that this plan involves a great outlay in insulated copper conductors, but such is not the case. With 30 lengths of surface conductor per section, the total length of service leads is seven miles per mile of track, and as a car is always supplied by two service leads in parallel, each has to carry only one half the current necessary for one car during the time occupied in travelling over 8ft. to 9ft.—that is to say, about one second at normal speed. The service leads may therefore be of comparatively small section. A seven-eighteen conductor will be sufficient for all ordinary requirements. The fall of potential has to be considered rather than the carrying capacity, as the absence of sparks in the distributor depends upon the former being kept small.

The small outlay in service leads is more than compensated for by the absence of moving mechanism under the roadway, the simplicity and small dimensions of the conduit, and the consequent minimum of disturbance to the existence track involved in adapting it to this system.

The distributors are simply a number of electromagnets (one for each length of surface conductor) excited by a shunt current only (one terminal of each is connected to the corresponding service lead and the other terminal to the return). Each magnet operates three contacts—one when it is excited, and two when it is not excited. Of the latter two, only one is actually in use at any given time, which one depending upon the direction in which the car is travelling. The connections are so arranged that before the car can receive a supply through any given surface conductor the corresponding magnet must be excited, and the two magnets corresponding to the surface conductors next but one in advance and next but one in rear must not be excited. The car carries two collectors or slippers placed apart about one-third the length of the car, and electrically connected together, and to one terminal of the motor. These rub or slide along the surface conductor, and the current after passing through the motor is led through the permanent way rails back to the source of supply. (In cases where the use of the rails as a return might be objected to, an insulated return can be provided without the introduction of additional surface conductors into the roadway, and at a small extra cost.) As the car advances, and the forward collector touches a surface conductor not yet charged, the latter becomes charged by reason of being short-circuited with the charged conductors in rear. A current passes through the corresponding service lead and magnet to earth, and the latter, becoming excited, operates two contacts, one of which puts the surface conductor just entered upon into communication with the main conductor, the other at the same time cutting out the next but one in rear. During this operation the car receives its current through the surface conductor lying between these two. The main current is thus never interrupted. In this way it is ensured that the conductors covered by the car, and these only, are in electrical communication with the main conductor, and although a moving car can always draw its supply of current from the surface conductors, it is impossible for persons or animals to come into contact with a charged conductor unless indeed they crawl under the car. When no current is required, as, for instance, when the car is at rest or going down hill, the conductors under the car are always charged, the current used to propel the car operating in no way to effect this; the result is brought about by the combined movements of the collectors along the surface conductor, and of the contact makers in the distributors.

I have stated that when any magnet is not magnetised it closes two contacts, but that only one of these is in use at any given time. This arrangement is to enable the car to proceed in either direction at any moment.

The experiments on this system, which have been carried out at the works of Messrs. Merryweather and Sons under circumstances so trying as to put a severe strain on any system, have been attended with such success as to justify the opinion of those who were made acquainted with the system, and satisfy its supporters as to its practicability and ultimate success.

The work had to be carried on without interfering with the busy traffic in a large engineering works; the track has been repeatedly flooded during the testing of fire engines, and the distributors themselves have frequently come in for an occasional copious shower bath.

It has been suggested to the writer that if the track were very wet a current sufficiently large to energise one of the magnets might leak across from a charged surface conductor to the adjoining one, and thus put the movements in the distributor out of step, so to speak, with the movement of the car. Were such the case, the difficulty could be easily and effectually remedied, by attaching to the rear end of the car a supplementary slipper electrically connected to the frame of the car or to the return lead. This would put each length of surface conductor to earth or zero potential immediately the car passed over it. In practice, however, it has been found sufficient to make the distance between the surface conductors about 3in., but the above device, being so simple, might be advantageously used as an additional security against any possibility of the distributor getting out of step with the car or a charged surface conductor being left exposed.

The cost of adapting an existing tramway to this system would be about £2,000 per mile of single track.

THE ELECTRIC TRANSMISSION OF POWER.*

BY GISBERT KAPP.

Lecture I.

The transmission of power, in whatever way it may be effected, is one of the most important problems in applied mechanics. Strictly speaking, it enters into and is, indeed, precedent to the application of power to all industrial operations. The power developed in a Lancashire mill engine only becomes of value to the spinner or weaver after it has been transmitted to the mules or looms by the agency of ropes, belts, pulleys, and other gear. Without such gear effecting the transmission, the power developed by the local steam engine would be as useless to the millowner as the power which may be contained in a waterfall miles away. In either case transmission must precede the application of power, but whilst in the former case the problem of transmission is simple, and has to be attacked rather from the point of view of convenient subdivision than with particular regard to efficiency (this being naturally high with properly designed gear), in the latter case the problem is of a much more difficult character, and efficiency, combined with moderate capital outlay, small working expenses, reliability, and safety, become matters of first consideration.

We have thus to distinguish between two kinds of power transmission, the one taking place over distances reckoned by or yards, and the other over distances reckoned by ands of feet, or even by miles. When we speak of the ric transmission of power, we tacitly assume that it belongs latter class, and refers to distances beyond the reach of the ary gear, such as shafting, cogwheels, pulleys, and belts, oyed for the subdivision and distribution of power within valls of a factory ; and it is in this generally accepted sense I propose to bring the subject mainly before you. There however, cases where the application of electromotors to al tools is either the most convenient or only possible od of applying mechanical power to the performance of in operations, and it will, therefore, be necessary at least ly to glance at that part of our subject which is not usually prised within the title of these lectures—namely, the trans- ion of power over very short distances by means of electric ents. We thus distinguish between "long distance" and ort distance" transmission, the fundamental distinction een the two being that in the former the transfer or trans- ion of power from one point to another, so to speak, in , is our main object, whilst in the latter we rather aim at subdivision and convenient application of power, in small ntities, at various points, and for particular purposes. I pose to consider long-distance transmission first.

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* Cantor lectures delivered before the Society of Arts.

roadly speaking, there are two ways in which we can nsmit mechanical energy from one place to another. Let assume, by way of example, that the primary source of rgy is coal, and that the power derivable from this coal is uired, not at the pit's mouth, but at a mill a certain number miles away. In such a case the obvious, and also the most nomical, way of transmitting power is to carry the coal to mill, and burn it under the boiler of the mill engine. Even e distance between the pit and the mill is short, this method l be the best, provided there are no difficulties of transport. ppose, however, that, although the distance is short, local ditions, such as great difference of level, bad roads, or total ence of roads, render the carriage of coal difficult or impos- le, then we would establish our boiler and engine at the pit, erate the power there, and transmit it by wire rope, or in ne other way, to the mill. In both cases we have transmission power, but the methods are essentially different. In the t case we have transmitted, not mechanical energy itself, the thing from which mechanical energy can be obtained, nely the coal, each ton of which represents so many stored se-power hours. In the second case we have transmitted energy itself in its kinetic or potential form. In popular guage we might describe the process as the transmission of ive" power, as distinguished from the transmission of tored" power, which takes place when we carry coal from pit's mouth to the mill.

The most important sources of power in nature are corn, coal, d falling water. Under the term "corn" I comprise all getable food-stuffs suitable for conversion into mechanical ergy, by means of horses and other animal engines ; whilst e term "coal" naturally includes all kinds of fuel suitable conversion into mechanical energy by some form of heat gine. The power derived from corn and coal is generally nsmitted in the stored form ; that derived from falling water the live form, since the conveyance of water at a high level, under considerable pressure, to great distances necessitates e erection of very costly works. To prevent misunder- anding, I must here point out that I use the term "stored ergy," as applied to water, merely in its colloquial nse. We speak of the energy stored in the water of a ill-pond, but, in reality, the energy does not reside in e water at all, but is an effect of its elevated position, and therefore, not comparable with the energy which is chemi- lly stored in coal. Leaving, however, such distinctions on e side at present, we may regard water, which is being carried ong horizontally, at a certain elevation, from one place to nother, as the vehicle of so much stored energy, which we can btain in its live form at any point at which we establish a ater engine, through which the water passes in its descent to a wer level. If we carry water along in this way, it is not with he object of bringing the stored power to the point of applica- ion, but merely to secure the largest possible fall, and, there- re, a maximum of power with a given quantity of water. If be necessary to transmit the power farther, the transmission generally effected in the live form. Now let us see what osition electricity occupies in relation to these primary sources f power in nature—namely, corn, coal, and falling water.

In the first place, it will be obvious that, where electricity is he transmitting agent, we can effect the transmission both in he stored and in the live form. To see this clearly, we need nly for a moment revert to our example of the coal pit and the mill. Instead of sending the coal to the mill to be converted into power there, we could burn it at the pit, and thereby generate steam to be used for driving a steam dynamo. The current from the dynamo we could utilise in charging a storage battery, and send this to the mill, where it would drive an electromotor, thus taking the place of the local steam engine. Here we have a system of transmitting energy in the stored form. On the other hand, if we do away with the batteries as a vehicle of energy, and connect the dynamo at the pit with the motor at the mill by a pair of insulated wires, we have a system of electric transmission of power in the live form. The latter system is that generally understood under the term "electric transmission of power," and therefore forms the principal subject of these lectures ; but before entering upon it, I propose briefly to investigate the capabilities of electric transmission of power in the stored form.

As you all know, a sack of coal contains more storage power than a secondary battery of equal weight, and its carriage, whether by rail or road, is cheaper, easier, and requires less precautions than that of the battery. It is, therefore, quite obvious that, if the primary source of power is coal, and if there is no objection to the establishment of a steam engine at the place where the power is wanted, it will be more economical to carry the power there in the form of coal than in the form of batteries ; not only because of the saving in carriage, but also on account of the smaller capital outlay, the smaller depreciation, and the avoidance of the loss of energy in the battery itself. But let us assume that the primary source of energy is falling water, then it is not so obvious at the first glance that its electric transmission in the stored form should be uneconomical. We cannot produce coal out of the energy of falling water, but we can charge batteries with it, and electricity would thus seem to offer a means of utilising a power of nature which would otherwise be lost. It might, perhaps, here be objected that electricity does not form the only means for utilising such a power, since there are various other ways in which power may be stored, a familiar example being compressed air. We might, therefore, also utilise the power of the waterfall for working an air compressor, and store the air under pressure in steel reservoirs, to be used afterwards for working air engines constructed similarly to ordinary steam engines. Many such engines are actually in use in Paris on the Popp system, though there the air is conveyed to them by pipes under pressure, and not in storage vessels, as would be the case in our example. There can thus be no doubt that the transmission of power by stored air is practicable, but the question is at what cost will it be effected, and can it compete with transmission by batteries? The answer to these questions depends on two factors—namely, the storage efficiency, and the cost of transport. By storage efficiency I mean the ratio of the power put into and taken out of the apparatus which serves as the vehicle for the power. Batteries may now be obtained in which this ratio is about 80 per cent.—that is to say, for every 100 horse-power hours put into the battery, 80 horse-power hours can be taken out. The storage efficiency of compressed air is very much smaller. The most reliable data under this head are to be obtained from the paper which Prof. Kennedy read before the British Association in 1889, when he gave an account of experiments carried out at Paris on the Popp system. He found that the indicated efficiency with cold air was 39 per cent.—that is to say, for every 100 h.p. indicated by the compressing engine, 39 h.p. were indicated in the engine driven by compressed air as it came from the mains. If the air before being admitted to the engine was heated to 320deg. F., the apparent indicated efficiency rose to 54 per cent., but as the heat energy thus supplied to the air requires the expenditure of fuel at the point where the power is wanted, the use of hot air really involves two methods of transmission—namely, that of power in the shape of air under pressure flowing through the mains, and that of power in the stored form contained in the fuel. To make the comparison with electric transmission of stored power a fair one, I must therefore take the efficiency of the Popp system when the air is not heated. A correction must, however, be made for loss of power in the mains. In the Popp system the power is transmitted in the live form by air flowing through pipes, and there is necessarily a certain loss on account of friction in the pipes and valves. As far as the friction in the pipes is concerned, this would not occur if the transmission were effected in the stored form by means of air carried under pressure in a reservoir, but, on the other hand, the loss by friction through valves would be greater, because it would be necessary to insert between the reservoir and the air engine a reducing valve, which would regulate the supply of air as the pressure falls. The loss of power due to this circumstance will probably be greater than the corresponding loss in the Popp system, where the pressure is constant ; but as I have no experimental data to determine this point, I take the same loss as found by Prof. Kennedy—namely, 2 per cent.—which makes the indicated efficiency nearly 40 per cent. The efficiency of the air engine he found to be, with cold air, 67 per cent., making the total efficiency of the system 26·7 per cent. By adopting air storage we could therefore obtain 26⅔ horse-power hours for every 100 horse-power hours indicated in the engine. Now let us see how the case stands with electrical storage. The efficiency of the steam dynamo—that is, the ratio of the electrical output to the indicated power—may be taken at 83 per cent.; that of the batteries 80 per cent.; and that of the motor at least 85 per cent.; so that the total efficiency works out to quite 56 per cent., or more than twice that of the rival system. I have here assumed that the dynamo is steam driven, simply because the only reliable figure

I could obtain about compressed air referred to steam-driven compressors, but it is obvious that the comparison of the storage efficiencies of the two systems cannot be materially affected by the source of power, and will practically be the same in the case under consideration, where the power is supposed to be derived from falling water. We see that in efficiency, at least, air storage is far behind electrical storage. Let us now enquire whether it is any better off in the other essential feature I have mentioned—namely, in the cost of carriage. The information available under this head is tolerably reliable as regards batteries, but this is not the case as regards air stored under pressure. I know of no experiments made to determine accurately the weight of air reservoirs, and in the absence of such data I cannot do better than adopt the calculated figure given by Prof. Osborne Reynolds in one of his Cantor lectures delivered in 1888. According to this authority, the weight of the steel reservoir and air contained would amount to 300lb. for every horse-power hour so stored. Now, the weight of a secondary battery filled with liquid, and provided with a tray and connections, all complete, does not exceed 100lb. per horse-power hour stored—that is, only one-third the weight of an equivalent air reservoir. We see, therefore, that as regards efficiency, air storage is twice as bad, and as regards weight, it is three times as bad as electric storage. Competition with it is, under those circumstances, obviously impossible; and we may therefore say that if the transmission of power from the waterfall to a distant point has to be made in the stored form, electricity is the only agent which need be considered.

Whether it would pay so to transmit power is a question which cannot be answered off-hand. As compared with the direct transmission of live power by means of a pair of wires, the cartage of batteries up and down the country will no doubt appear to be a clumsy device, but when we are investigating the different possible solutions of an important problem we must not allow any preconceived opinions of what is elegant or clumsy to influence our judgment—we must, in fact, judge each case on its own merits, and I propose to deal with the electric transmission of stored energy in this sense. The system of power transmission by storage batteries is actually in use, not, indeed, for long-distance transmission pure and simple, as above defined, but still for transmission over distances reckoned by miles. I allude to the electric tramcars worked by storage batteries which are charged at a central depot, and run for many miles before they require to be again charged. The object is not to carry a certain amount of power in bulk from one point to another, but to dispense whatever power is required for the propulsion of the car during the journey. We might, however, imagine the tramcar, instead of being occupied by passengers, to be loaded with storage cells in addition to those it carries for its own propulsion. Whilst the latter would gradually lose their charge in transit between the two terminuses, the former would arrive fully charged, and could be made to give up part of the power stored in them at the starting point. Here we have transmission of power in the stored form, but let us return to our example of the waterfall and the mill, and see how such a system might be put into operation.

At the waterfall we establish the necessary hydraulic works, and an electric station where the batteries can be conveniently charged. We further build a tram line or railway, joining the charging station with the mill where the power is wanted, and we design the rolling-stock with special regard to the safe and convenient carriage of the batteries to and fro. The train is fitted with electromotors, so as to make it self-propelling. A trainload of charged cells is thus taken to the mill, and left there to work the electromotor which supplies power to the mill. During this process the batteries becomes gradually exhausted, and must be disconnected from the motor before they are quite exhausted, because we must allow a sufficient margin of power for taking the train back to the charging station. The economy of the whole system will evidently be the greater the less power is spent in the outward and home journey; and we might call "efficiency of transmission" the ratio of the power actually delivered to the motor, and that which might be so delivered if the battery were used for working a motor at the charging station itself: in other words, if the distance of transmission were nought. Say, for instance, that a total of 1,000 horse-power hours could be obtained from the battery, if it were discharged immediately, and that the power spent in the outward journey amounts to 50 horse-power hours, then a further 50 horse-power hours will have to be spent in the return journey, and the power obtainable at the mill will only amount to 900 horse-power hours. The efficiency of transmission will in this case be 90 per cent. If we double the distance between the waterfall and the mill, the efficiency of transmission would be reduced to 80 per cent. If we treble the distance, the efficiency would only be 70 per cent., and so on. The efficiency must naturally depend on the kind of road over which the transmission takes place. It will be small on a common carriage road, larger on a tramway, larger still on a railway, and largest on a canal. We can, for every arrangement, express the value of the system, as far as economy of power is concerned, in one of two ways. We can, if the distance is fixed, give the efficiency in the usual way as a percentage, or we can fix a standard percentage of efficiency, and ascertain the distance over which this standard is attainable in any particular case. I shall adopt the latter way of reckoning, as the more convenient for comparison with other methods for transmitting power, whether in the stored or live form.

First, as to transmission of stored power otherwise than by batteries. The only two methods we need consider are the carriage of corn and the carriage of coal, each combined with the use of a proper engine for converting the stored into live power at the other terminus of the line of transmission. In the case of corn, the starting point of this line is the field where the corn is grown. We there load it into suitable vehicles, and send it to the mill where the power is wanted. Since we are dealing now entirely with animal power, we must suppose the cartage to be effected by draught animals, say horses, and the conversion of corn into live power at the mill also by such animals.

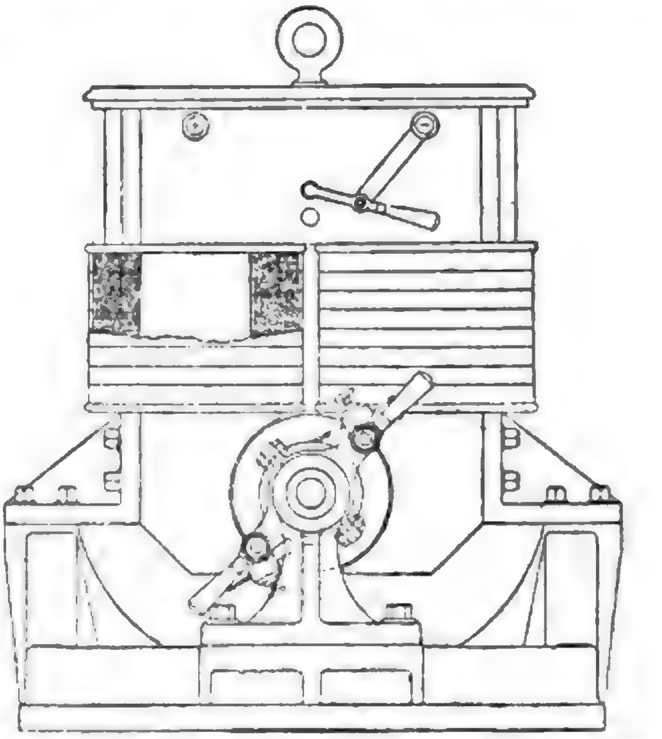
(To be continued.)

THE ELECTRIC LIGHTING OF PUBLIC BUILDINGS; WITH SPECIAL REFERENCE TO THE ATHENÆUM ELECTRIC LIGHT INSTALLATION.*

BY PROF. JAMIESON, M.INST.C.E., F.R.S.E.

(Concluded from page 21.)

Mr. M'Whirter said that Kapp gave as a safe armature load 1,000 ampere-turns for each 1in. diameter – 5in.; call the diameter of this armature 14in., then by Kapp's rule it should carry 900 ampere-turns, or only about one-half its present load. This would be more in harmony with everyday practice, and attended by better results. How these were ever made for an output of 26 units at 600 revolutions (as they were originally) was more than can be easily explained, and, in fact, was more work than they ever did in anything like a satisfactory manner. Prof. Jamieson had entirely left out a very important point. He said nothing at all about the heating of those machines. Now, as these were put forward as ideal machines for public lighting, this was a point of very great importance, and ought to be thoroughly discussed. The heating of field magnet coils was easily calculated from the formula given by Esson at the Electrical Engineers. It was of course directly as the watts lost in the coils, and inversely as the surface available for the radiation of the heat. The ultimate rise of temperature in degrees centigrade was given by the equation



Faraday Dynamo. Single Field—Vertical. 18 Units at 500 Revolutions. (Designed by Mr. M'Whirter, see last week's *E.E.*, p. 21.)

$$\text{Cdeg.} = \frac{W \times 55}{8}$$

where W was the rate at which energy was to be dissipated in watts, S the cooling surface in square inches, and 55 a constant for double cotton covered and varnished wires on field magnets. Taking the dimensions of the magnet coils as 12·75in. diameter, the length as 10·5in., then they had

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* Discussion on paper read before the Institution of Engineers and Shipbuilders in Scotland, *vide E.E.*, May 1, 8, 22, 1891.

$$\text{Cdeg.} = \frac{1{,}017 \times 55}{840} = 60\text{deg.};$$

and this added to the temperature of the engine-room, which might reasonably be taken as 20deg., would bring up the temperature to something like 87deg. C., a condition not at all favourable to a long life for any machine. If, however, they applied the same test to the dynamos called Nos. 1 and 3, a reasonable voltage for charging 58 cells would be 140 at the terminals of the dynamo. The resistance being taken at 11·5, then they found that

$$\text{Cdeg.} = \frac{1{,}711 \times 55}{840} = 112\text{deg.}$$

He was very pleased to see, from the remarks made by the author, that there was a likelihood of his being able to add to the paper the whole particulars of tests; and he felt sure that this would make the paper of considerable value.

Mr. W. B. Sayers said the title of the paper would lead one to expect a fairly comprehensive treatment of the subject of lighting of public buildings by electricity, but unfortunately this was by no means found to be the case. Notably there was nothing in the paper about the way in which the wiring of the building should be carried out, or information as to how it had been done in the case of the Athenæum. He had taken advantage of Prof. Jamieson's offer, and had viewed the Athenæum installation; and he should like to ask Prof. Jamieson to state whether the information that there were no fuses employed except in the switches and ceiling roses, and in the mains at the switchboard, was correct? If this were so, a considerable length of the branch wire must in each case be unprotected by any except the main fuses, which were far too heavy to break before a branch wire became dangerously overheated in case of a short-circuit—a state of things which no fire insurance inspector up to his duty would or indeed ought to pass. Everyone who had had to do with the lighting of large spaces by means of incandescent lamps, would agree with the author of the paper as to the excellence of the Sunbeam lamps for this purpose. The space covered in by the Caledonian Railway bridge in Argyle-street was a good example of this. It was lighted by nine 200-c.p. Sunbeam lamps—the lamps forming part of the large installation which had just been completed by Messrs. Mavor and Coulson in the Caledonian Central Station and Hotel, which were now lit throughout by electricity. As Mr. Mavor dealt with Prof. Jamieson's statement that it was necessary to increase the pressure as the lamps got older, he would only point out two obvious ways of dealing with old lamps, and those adopted at the Central Station, which were (1) to move the old lamps into lavatories and places where small light was sufficient, and (2) to move them to places nearer the dynamo or source of supply, as there would generally be three or four volts difference of pressure between the two ends of the distributing cables and wires. The fact that he found triple expansion Westinghouse engines in use at the Athenæum, and that, while no mention of these was made in the paper, a compound Westinghouse engine was illustrated on the sheet, led him to enquire whether the table given in the paper showed the results of actual tests with the triple expansion engines, or forecasts of the expected results when these had been replaced by compound engines, which he understood was in contemplation. Prof. Jamieson, in his reply, stated that the tables were the results of actual tests, which statement he (Mr. Sayers) of course accepted; but it would be interesting to hear the explanation of the discrepancy between what actually existed and the illustrations in the paper in the matter of the engines. It would be a distinct advantage to run up a light partition to divide the engines and dynamos and switchboard from the boilers, in spite of Prof. Jamieson's arguments in favour of having them all in one compartment. This view, which he took from first seeing the paper, was emphasised when, on looking at the switches, and thinking they were somewhat light for the current they were said to carry, he ventured to touch the contact of one of them, and got his finger burned for his pains, although the current passing at the time was only 80 amperes, the switches being supposed to be capable of carrying 200 amperes. This heating was due partly no doubt to the switches being light, but also to their having the contact spoilt by the fine dust and grit which covered everything.

Prof. Jamieson said that as the time was so late (10.15 p.m.) he would answer the various speakers in writing. He was glad that so many points had been touched upon in the discussion, and he would endeavour to combat the different objections that had been raised to his views as expressed in the paper.

The **President** said he thought it must be apparent to everyone that Prof. Jamieson had, according to his light, devoted a great deal of attention to this subject in a thoroughgoing manner, and he had spent a great deal of time over it; and, therefore, the least they could do was to accord him a very hearty vote of thanks.

The vote was heartily accorded.

Prof. Jamieson sent the following reply in writing: Referring to Mr. Thom's remarks regarding high *versus* slow speed engines, the author was well aware of the increased economy derivable from working with a high piston speed. He had tested many engines of different kinds for the consumpt of steam per indicated horse-power and per boiler horse-power. In fact, it was only a day or so before that he had occasion to test a novel kind of rotary steam engine invented by Mr. Brown, of Swindridgemuir, Dalry, Ayrshire, which engine gave a consumpt of 47·5lb. of steam per boiler horse-power hour when run at 274 revolutions per minute, but over a continuous five hours' trial the consumpt was reduced to 37·9lb. steam per boiler horse-power hour when run at a mean speed of 574·5 revolutions per minute. This worked out about 27lb. per indicated horse-power from the indicator cards, taken with M'Innes indicator. The cylinder of this little rotary engine measured only 10½in. diameter by 8¾in. deep, of which nearly one-half of the volume of the cylinder was occupied by the revolving piston, and it developed a mean of 20·78 boiler horse-power, with steam of 80lb. pressure per square inch in the cylinder.

The author was, however, glad to see that Mr. M'Whirter agreed with him in regard to the advisableness of employing, under certain circumstances, engines with a fairly long stroke, and fewer revolutions per minute, than those with a great number of revolutions per minute. It was not altogether a case of steam economy that the electrical engineer had to consider, for he had to take all these circumstances into account when ordering engines, and to weigh carefully how the total expenses would stand at the end of, say, one, two, or more years.

Mr. M'Whirter, near the commencement of his remarks, referred him to the discussion which took place at the Institution of Electrical Engineers on Prof. Forbes's paper (not last year, as stated by Mr. M'Whirter, but March 14th, 1889) on "Some Electric Lighting Central Stations and their Lessons" for the consumpt of steam by Willans's engines. He had looked up the *Proceedings* of that Institution, and found that Willans's engines were not referred to there in this light; but Mr. Robinson, the partner of Mr. Willans, said (at p. 229, *Proc.* Inst.E.E.), in reference to Prof. Forbes's hearsay statements regarding a 400-h.p. compound Corliss condensing engine in the central station at Berlin, using only 15·5lb. of water evaporator per electrical horse-power hour: "One cannot but wish for detailed figures of such tests as these, and for fuller particulars generally. Certainly we cannot match such figures as in England yet . . ." "I have seen an English condensing engine giving an indicated horse-power upon 15·1lb. of water." It was, therefore, quite evident that Mr. M'Whirter was mistaken. The author would feel much obliged for any reference to any authentic case wherein the consumpt of steam in any slow or fast speed non-condensing engine was less than 20lb. per hour per electrical horse-power, or 15lb. per indicated horse-power, since the double of those values were considered very good work. They must always take care, when speaking of the consumpt of steam per horse-power, that they knew exactly whether it was per indicated horse-power, or boiler horse-power, or electrical horse-power, for it made a very great difference to the results; also, whether the engine was a condensing or non-condensing one, or a simple compound or triple expansion engine.

Mr. Thom at the end of his remarks said, "It makes matters worse when you arrange the boiler to slide along the bottom." The boilers were not arranged as he supposed, but merely given freedom to cant over under the expansion of the steam dome. If the distance between the junctions of the boilers to the steam dome did expand ¼in., this would only mean $\frac{1}{16}$in. at the extreme ends of the two boiler seats, and here they had freedom to expand. Mr. Couper said: "In regard to the receiver which one gentleman had taken exception to, he might say that they did not approve of that either. They suggested a connection by a copper pipe, but Prof. Jamieson, as the consulting engineer, preferred a rigid connection, and went into the matter of expansion, to see how much expansion took place. . . ." This was not strictly true, for Messrs. Lindsay, Burnet, and Co., of which firm Mr. Couper was a partner, sent in their competitive tender, design and specification with rigid connections, without any suggestion or remarks *re* this point. Their tender was accepted, but before the firm began to make the boilers, he requested them to give him a design for a more flexible system of connections between the boiler and the steam dome. Their new design and extra price for this alteration was not accepted, for various reasons. The firm agreed to fit the connections with freedom faucet-joints, and to give further freedom from expansion in the different ways already mentioned. They thought, and all were agreed, that this would prove satisfactory, and as Mr. Couper remarked, "it had not given any trouble that he knew of."

To finish off the boiler question. Mr. Burnet, in his remarks, said, "One would have expected that a well-known public teacher like Mr. Jamieson would have treated this part of the subject in more exact language than to speak of horse-power of boilers without defining that horse-power in some way. The Athenæum boilers might be 60 of that unknown quantity, if you coaled them to that extent, but from Table IV. at that output, the heat efficiency was only 58·6 per cent." Mr. Burnet agreed in his tender to give them 60-h.p. boilers, on the assumption that an indicated horse-power required 25lb. of steam per hour at 150lb. pressure. The Babcock-Wilcox Company always stated the power of their boilers as equivalent to 1 h.p. for every 30lb. of steam raised per hour at a certain pressure. He admitted the laxity of language used in this instance, more especially as the weight of steam (stated in Mr. Burnet's tender) per horse-power hour was lower than the general rule!

Mr. Burnet (as well as others) complained of the want of details in regard to the results given in Table IV. He should be only too glad to furnish these, but when they remembered how Mr. Burnet withdrew from the *Proceedings* of that institution the sectional drawings of the boilers and the feed-water heater, which his firm had given him liberty to make use of for the purpose of this paper; further, when they learnt that he had offered to place his whole services at his disposal for a twelve hours' trial of the boilers in question, and that he declined to accept the same, he could not but gather that he (Mr. Burnet) wished to keep matters quiet. However, since he and others had requested figures, he had, as they would observe, given full details of how the boiler efficiency was arrived at, and now supplemented these by the following Table V., which showed the main dimensions of the boilers, and by Table VI., which gave one set of his tests most closely approaching to the contract tender for the two 60-h.p. boilers at 25lb. steam per horse-power hour. In this case, the efficiency was found to be 60·6 per cent., and as far as the mere steaming qualities of the boilers were concerned, he had no fault to find.

TABLE V.—DIMENSIONS OF THE ATHENÆUM BOILERS.

Type—Dry back tubular.
Number of boilers—2.
Diameter of boilers—5ft. 9in. inside.
Length of boilers—5ft. 9in. inside.
Number of tubes in each boiler—62.
External diameter of tubes—2¼in.
Furnace tubes—length, 5ft. 9in.; diameter, 2ft. 6½in. internal.
Fire grate—length, 4ft. 3in.; width, 2ft. 6½in. mean.
Grate area—10·8 square feet each; 21·6 square feet both.
Heating surface—In furnace, 30·6 square feet; in tubes, 233·3 square feet; total for both boilers, 528 square feet.
Height of chimney from firebars—110ft.
Sectional area of chimney—5 square feet.
Sectional area through tubes of both boilers—3·04 square feet.
Heating surface for each square foot of grate area—24·4.
Heating surface of feed-water heater—51·5 square feet.

TABLE VI.—DETAILS OF A TEST OF THE ATHENÆUM BOILERS.

1.	Duration of each test	5¼ hours.
2.	Heating surface	528 square feet.
3.	Grate area	21·6 square feet.
4.	Coal burned per hour	355lb.
5.	,, ,, per square foot of grate area	16·4lb.
6.	,, ,, ,, ,, heating surface	·67lb.
7.	Water evaporated per hour	2,425lb.
8.	,, ,, per square foot of grate area	112lb.
9.	,, ,, ,, heating surface	4·5lb.
10.	,, ,, per lb. coal at feed temperature	6·8lb.
11.	,, ,, ,, 212deg. F.	7·58lb.
12.	Temperature of feed in tank	34deg. F.
13.	,, leaving feed heater	145deg. F.
14.	Rise in temperature due to feed heater	111deg. F.
15.	Temperature of chimney gases	550deg. F.
16.	Chimney draught	1in. water.
17.	Calorific value of the coal in British thermal units	12,500.
18.	Pounds of water that would be evaporated from and at 212deg. F. with perfect combustion	12·5lb.

19. Efficiency of boiler (theoretical) $= \frac{7{\cdot}58}{12{\cdot}5} \times 100 = 60{\cdot}6$ per cent.

From another Set of Tests.

(1)	Coal (of above quality) per i.h.p. per hour (net)	4·7lb.
(2)	,, ,, e.h.p. per hour (net)	6·7lb.
(3)	,, ,, e.h.p. per hour, taking the amount required for the feed pump and the steam jet into account for 26 working days in February and March, averaged about	10lb.

Mr. Burnet said, "It would be of great interest here to know how a value was arrived at by Mr. Jamieson in making up his complete statement of cost of light to the Athenæum proprietors, as compared to equal light bought from a central station." This he had pleasure in giving by the following Table VII. :

TABLE VII.—COST OF RUNNING THE ATHENÆUM ELECTRIC LIGHTING PLANT.

From the Mean of 26 Working Days in February and March.

	Cost per day.		
1. Coal, 56 tons, at 13s. per ton	£1	7	3
2. Wages of engineers and fireman	0	10	1
3. Oil, waste, etc.	0	0	9
4. Water, at £4 per month	0	3	0
5. Rent of engine-room	0	3	0
6. Depreciation of plant, 12½ per cent. per annum on £2,500	0	17	1
	£3	1	2

So that the £3. 5s., or 4d. per Board of Trade unit, as stated on the diagram of the load curve, appeared to be more than sufficient for the case under consideration.

Mr. Burnet stated "that with the grate area as used at the trial, which was as much as one-sixteenth of the total heating surface, it would require great skill to prevent waste of fuel, and it would here be interesting to know if the forced draught appliance was in use at the time." The correct ratio of these quantities, as would be observed from Tables V. and VI., were—

$$\frac{\text{grate area}}{\text{total heating surface}} = \frac{21{\cdot}6}{528} = \frac{1}{24{\cdot}4}$$

Meldrum's steam forced draught was in use during this trial, and the firing was most skilfully looked after by a marine-going engineer. They had at the Athenæum as steady, reliable men to look after the boilers, engines, and dynamo plant as would be found anywhere; besides which he asked Mr. Burnet to bring with him the most skilful fireman he could get, in order to prove the results of their tests, and to make comparative trials with and without the forced draught, but he never came. *Re* the writer's remarks about right-angled bends and throttled passages, he certainly was impressed by the very poor draught, and the density of smoke from the old chimneys. This chimney, together with three ordinary vents, had been connected to the boiler's smoke-boxes, with a many right-angled sheet iron flue, by Mr. Burnet's firm. The primary cause of the failure was due, however, to the too small cross area and height of the old chimney, with which, and the three ordinary fireplace vents, they had been requested to do their best. The vents did not pull well with the boiler chimney, and although a steam jet was introduced into each of these outlets (which so far helped the draught), in certain conditions of the atmosphere the draught was not more than a quarter of an inch of water pressure. It soon became evident that this makeshift arrangement would not effect the desired object, and they therefore employed Messrs. Braby and Co. to erect an iron chimney, with flues leading thereto having easy bends and large area, which now gave, under normal conditions, a draught equal to one inch of water pressure.* The height of the top of this chimney was 110ft. above the furnace grates, and it was 2·5ft. in diameter, or 4·9 square feet in cross area, instead of the old chimney, which was only about 75ft. high, and 2·1 square feet in cross area. The formula he used for the dimensions of the new chimney was :

$$A = \frac{2{\cdot}4\,G}{\sqrt{H}} = \frac{2{\cdot}4 \times 21{\cdot}6}{\sqrt{110}} = 4{\cdot}9 \text{ square feet,}$$

where A represents the cross area of chimney in square feet,
,, G ,, surface area of fire grates in square feet,
,, H ,, height of chimney in feet.

The draught obtained from this chimney was all that could be desired with or without the forced draught, but they were met with the local legal demand to make as little smoke as possible. Mr. Burnet suggested that they should still further diminish the length of the fire grates, and give up the forced draught. This would most undoubtedly again have brought them before the magistrate. They would try a smaller area of fire grate, so as to burn more coal than 16·4lb. per square foot of grate area, and ·67lb. per square foot of total heating surface, but most certainly they could not do so without the aid of the forced draught when and for some time after firing, unless they were permitted to make black smoke with ordinary triping coal. One further advantage of the forced draught was, that it kept the boiler tubes so clean that they had only to sponge them twice a week.

Mr. Mavor objected to their method of increasing the voltage as the lamps got older. When, however, it was explained that at the beginning of the Athenæum's session a fresh set of lamps were introduced into all the most important positions, that these lamps as a rule lasted the whole year, and that should any of them give way before that time they were replaced by the best of the old lamps previously taken out; further, the plan mentioned by Mr. Sayers was also adopted as far as possible—viz., the oldest lamps were moved into unimportant places, or nearer to the dynamos—it would be evident that they did not think "this method of procedure utterly fatal to economical working." A convenient rule was given by Mr. Thomas G. Grier, in a paper read recently before the Chicago Electrical Club, and reprinted in the *Electrical Review* of London on May 8, 1891, whereby they might calculate the most economical length of time which a lamp of a certain efficiency could be used. The rule was as follows :

Let A = the number of watts required by a 16-c.p. lamp.
,, B = the life of the lamp at (A 16) efficiency per c.p.
,, Y = the cost of a 16-c.p. lamp.
,, X = the cost of a watt-hour delivered at the lamp.

Then, the most economical time to run the lamp would be when the cost of the renewal plus the cost of the power is a minimum.

Or, $$\frac{Y}{B} + (X \times A) = \text{a minimum.}$$

Taking the case of the Athenæum, where the cost of a Board of Trade unit, or "bot," was 4d., the cost of renewals (including accidental breakages, carriage, purchaser's risk, and interest) at 4s. per 16-c.p. lamp, it would be found most economical to run the lamps for fully 1,200 hours before replacing them by new ones.†

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[*] It is only by relating failures as well as successes that we make true progress in engineering. I have therefore pleasure in communicating my experiences on this important matter of draught and smoke; more especially as I have for some years advocated double the cross area of steam-pipes usually adopted, together with very easy bends. The formula which I have given for the cross area of a chimney has a larger constant than that found in any book which I have come across, but, nevertheless, I do not think it is too large for the height of chimney, and for multitubular boilers where the gases experience considerable friction, due to the tubes and the number of bends round which they must pass.

[†] Let a 16-c.p. lamp require a mean of 60 watts for 500 hours' lighting.
,, ,, 65 ,, 1,000 ,,
,, ,, 67 ,, 1,200 ,,
,, ,, 70 ,, 1,500 ,,

Then, from the above formula and data, we have

For 500 hours' lighting $$\frac{48\ (\text{pence})}{500\ (\text{hours})} + \left(\frac{4}{1{,}000}\,(\text{pence}) \times 60\ (\text{watts})\right) = {\cdot}336$$

For 1,000 hours' lighting $$\frac{48}{1{,}000} + \left(\frac{4}{1{,}000} \times 65\right) \ldots\ldots = {\cdot}308$$

For 1,200 hours' lighting $$\frac{48}{1{,}200} + \left(\frac{4}{1{,}000} \times 67\right) \ldots\ldots = {\cdot}3075$$

For 1,500 hours' lighting $$\frac{48}{1{,}500} + \left(\frac{4}{1{,}000} \times 70\right) \ldots\ldots = {\cdot}312$$

Thus proving that under these conditions as to increased current, with increase of age or decreased efficiency, it is cheapest to use the lamps for fully 1,200 hours' lighting.

In America the lamps cost only about 2s. each, and the power cost ·8 of a cent for 50 watt-hours, or 8d. per "bot," hence it would be seen that there it was more economical to throw away the lamps in a much shorter time than in their case. Also, when the public were supplied from a central station in this country at 8d. per "bot," it would be more economical to throw away their 16-c.p. lamps in less than 1,000 hours. With a *constant* voltage throughout the time a lamp was kept in place—say, 1,000 hours—the power required at the end of the 1,000 hours' lighting was less than at the beginning, since the resistance gradually increased, but the candle-power decreased. They knew, however, that the candle-power given out by a lamp near its normal voltage was very quickly increased by a small percentage increase in the potential difference at its terminals. Hence, it simply became a matter for experiment and calculation to determine the most economical life and maximum rise of voltage to be given to a set of lamps which were introduced at one time into a self-contained installation. The case was therefore different from that of a building supplied from a central station, where the voltage had to be kept constant; and considering the fact that steam was required daily throughout the whole year for cooking purposes, and in winter for heating the building, they were confident that it was cheaper for the Athenæum to run its own installation than to obtain current from a central station at the present prices charged, or likely to be charged for some years to come.

Mr. Mavor objected to the arrangement of having four medium-sized dynamos instead of two large ones. This arose, in the first instance, from the Athenæum possessing two of the present dynamos in their old installation, and it was found cheaper to convert them so as to suit the reduced speed and other requirements of the new installation than to purchase new ones. Further, it gave four strings to the bow instead of two. Any ordinary fiddler could play a uniform tune on four strings, but it took a skilled one to play even an irregular tune on two strings. Mr. Mavor suggested the use of a spare armature, but where would he be in the case of a short-circuit in the field magnet coils? They had reasons to be satisfied with the present arrangement, and if they had the plant to order over again, they would adhere to the same plan, for it gave greater flexibility in the management and for repairs.

Messrs. Couper and Sayers objected to the placing of the dynamos and switchboard in the same room with the boilers, but here again they contended that the plant was more easily attended to, and as yet they had not found that anything had been hurt or injured thereby, except Mr. Sayers's fingers. The reasons he gave for the switch being hot were not correct, for it was due to a dirty contact (from the effect of the breaking sparks on switching out the circuit) not having been properly cleaned.

He was sorry that he had not had time to check all Mr. M'Whirter's calculations in regard to the dynamos, but he had invited him to come and see them at work, and to observe how cool they were after a lengthened run. His formula must have been warmed up by an undue constant before application to the present case. Even assuming that the formula used by Mr. M'Whirter is correct, he had overstated the power lost in watts in the field magnet coils. For, referring to the characteristic curves which he obtained from No. 2 dynamo, it would be seen that at the maximum output for which the dynamo was made, it gave 140 amperes and 113 volts at 500 revolutions, with 4·5 ohms added to the shunt coils, which were 26·8 ohms resistance. Hence $26·8 + 4·5 = 31·3$ ohms total resistance in the shunt circuit. And 31·3 ohms ÷ 113 volts ÷ 31·3 ohms = 3·61 amperes in the shunt coils. The power lost per second *in shunt coils* alone was therefore $C^2R = 3·61^2 \times 26·8 = 350$ watts. Add to this the power lost in the main field magnet coils—viz., $140^2 A \times ·023\ \omega = 450$ watts—and they got a total of 800 watts, instead of 1,017 watts, as stated by Mr. M'Whirter. The maximum rise in temperature $= \frac{W \times 55}{S} = \frac{800 \times 55}{840} =$ 52deg. C., instead of 67deg., as stated by Mr. M'Whirter. But they did not require to run the dynamos at this maximum output, since they had four of them at their disposal, of which any two were capable of overtaking the whole of the lighting required at any one time in the Athenæum. In charging the cells the maximum rise in temperature of the shunt coils did not come to within 20deg. C. of what Mr. M'Whirter made it out to be. Here, however, he would admit that they had to be careful not to overheat the coils, since the current flowing through them was as much as they would comfortably withstand. The dynamos they had got in the Athenæum were very good machines, and Mr. M'Whirter's whole criticism amounted to this, that they should have been rated for a maximum of about 110 amperes instead of 140 amperes.

Mr. Sayers would have liked to have heard something about the different systems of wiring buildings, but to have gone into every side issue such as that would have unduly lengthened the paper. They had arranged the fuses as follows. Both the positive and the negative mains from each dynamo had been protected by a cut-out. Each of the branch mains to the different floors were provided with cut-outs at their positive and negative sides, at their very junction to the dynamo mains. Each subsidiary branch was protected on the positive side by a cut-out at the switch, which was close to the branch mains. Finally, each lamp was protected on the negative side by a fuse. This complied with the best fire risk rules, and was all that any fire insurance inspector up to his duty could or should demand. The discrepancy which Mr. Sayers had pointed out in regard to the existing engines and the illustrations was explained by the fact that the makers were about to supply the Athenæum with their latest make and design of Westinghouse compound engines, from which he expected even still better results than those recorded in the paper from the trials of the present ones. He should be glad to record the results of the work done by these new engines (with the makers' approval) after they had been fitted, which would be early in September next. At the end of the 12 months' run with the plant, they would be better able to place a record of the working expenses before this institution. It was only by carefully recording such facts over a lengthened period that true deductions could be arrived at in such a new industry as that of electric lighting.

Finally, he had to thank Messrs. Whitelaw, Eadie, Christie, Uren, Robertson, Watson, and M'Leod, electrical engineering students attending his day laboratory classes, for their kind assistance with the tests, drawings, and calculations for his paper.

Note received from Mr. M'Whirter, 25th May, 1891.

Prof. Jamieson has taken exception to Esson's formula, and called my attention to it. I have had an experiment carried out upon a dynamo in the works with the view to determine how far the formula agrees with results as found in practice. A current was sent through the coil wound upon a dynamo for three hours, the temperature being measured at regular intervals on the outside of the coil, and at the end of this trial—*i.e.*, when the coil had reached a temperature where the radiation was equal to the gain, and there was no further increase in temperature—it was found that the temperature measured on the outside of the coil was then equal to over 70 per cent. of the ultimate temperature as found by the equation given by Esson.

PHYSICAL SOCIETY.—June 26.

Prof. W. E. Ayrton, F.R.S., President, in the chair.

Mr. J. Enright, B.Sc., was elected a member of the society.

The following communications were read:

"**The Construction of Non-inductive Resistances,**" by **Prof. W. E. Ayrton, F.R.S.**, and **Mr. T. Mather**. In making some transformer tests about three years ago the authors had occasion to consider the construction of electric conductors, the impedances of which should be practically equal to their resistances. This condition could only be fulfilled by making the inductance small in comparison with the resistance, and as the former does not depend on the material employed (excepting iron) it was important to use substances of high specific resistance. Carbon or platinoid being available, the latter was chosen on account of its low temperature coefficient. One form of resistance exhibited consisted of strips of thin sheet platinoid, about 6 metres long and 4 cm. wide. Each was bent at the middle and doubled back on itself, thin silk being placed between the contiguous parts, and narrow ribbon used to bind the parts together. Twelve such strips arranged in series had a resistance of 2·95 ohms, and would carry a current of 15 amperes without changing its resistance more than $\frac{1}{10}$ per cent. This strip resistance was made by Messrs. C. A. Lamb and E. W. Smith, who at that time (1888) were students in the Central Institution, and to whom the authors' best thanks are due for the praiseworthy manner in which they surmounted the difficulties which presented themselves. Another form of resistance designed for portability consisted of bare wire spirals, each length having a left-handed spiral placed within a right-handed one of slightly larger diameter, and the two being connected in parallel. This device was found to reduce the inductance to $\frac{1}{8}$ or $\frac{1}{20}$ of that of a single spiral, according as the diameters of the spirals approach towards equality. When the spirals are made of platinoid wire the ratio of inductance to resistance is very small, averaging about [illegible].

"**On the Influence of Surface Loading on the Flexure of Beams,**" by **Prof. C. A. Carus-Wilson.** Referring to the practical treatment of problems on beam flexure, as based on Bernoulli's hypothesis that the bending moment is proportional to the curvature, the author pointed out that this assumes that the cross-sections remain plane after flexure and neglects the surface loading effect. The present paper describes experiments made to determine the actual state of strain in a beam doubly supported and carrying a single load at the centre, the effect of surface loading being taken into account. The method of investigation assumes that: 1. The true state of strain at the centre of a beam may be found by superposing on the state of strain due to bending only, that due to surface loading without bending. 2. The state of strain due to surface loading only may be found with close approximation to truth by resting the beam on a flat plane instead of on two supports. 3. The strain due to bending alone may be obtained from the Bernoulli-Saint-Venant results. Before proceeding to describe the experiments, a short account of the mathematical work previously done on the subject was given. The nearest approach to the particular case here dealt with had been worked out by Prof. Bouissinesq, who had shown that for an infinite elastic solid bounded on one side by a plane surface and loaded along a line on that surface, the stress, y, on an element on the normal through the middle point of the line varies inversely as its distance, x, from the surface The formula thus arrived at was $y = 0·64 \frac{P}{x}$, whilst for a finite beam, centrally loaded, the author's experiments gave $y = 0·726 \frac{P}{x}$. The experiments were made on glass beams mounted in a steel straining frame, and placed between the crossed Nicols of a polariscope. Steel rollers, 2 mm. in diameter, served as supports, and the central load was applied by a screw acting on a roller of similar diameter. Deflections of the beam were measured by a micrometer screw at a point opposite the central load, and traversing screws enabled the whole frame to be moved, so as to bring any portion of the beam in the field of view. Circularly polarised light was sometimes used, and a micrometer eye-piece served to measure the distances between interference fringes produced by loading. By carefully chosen experiments the author had shown that if a beam of glass be laid on a flat surface, and loaded across its upper surface, the shear at any point on the normal at the point of contact of the load is inversely proportional to the distance from the point of contact. In the first experiment the crossed Nicols were set at 45deg. to the axis of the loaded bar. A quarter-wave plate was then placed between the bar and the analyser, and the position of the black spot at the point where the effect of the shear on the polarised light was equal and opposite to that produced by the quarter-wave plate was noted. A second quarter-wave plate was then superposed on the first. The black spot moved upwards to a point where the shear was double that at the first position. This position having been determined, one quarter-wave plate was removed, and the load diminished, until the original spot moved up to the second position, and the processes were repeated. By this means a series of positions at which the shears were in the proportions, 1, 2, 4, 8, etc., were determined. Plotting the results showed the curve connecting the shear and the distance from the point of contact to be hyperbolic. Other experiments showed that the shear at any point was proportional to the load. By maintaining a constant load, and measuring the distances between the interference fringes below the point of contact, the hyperbolic law was confirmed. The effect of bending a beam is, according to hypothesis, to put the upper portion in longitudinal compression, and the shear (vertical stretch) varies as the distance from the centre of the beam. The shear due to surface loading is a vertical squeeze, and, as shown above, varies hyperbolically. When, therefore, the beam is subjected to both actions, the straight line representing the bending strain may intersect the hyperbola representing the shear due to surface loading in two points, and since at the corresponding points in the central section the shears are equal and opposite, the elements are only subjected to voluminal compression, and will exert no birefringent action. Hence, when viewed through crossed Nicols, black spots will be seen on a white field. Keeping the load constant and varying the span should cause the spots to approach each other, and when the line is tangential to the hyperbola the spots coincide. These deductions were confirmed by experiment, and it was found that for a span of less than four depths no point of zero shear exists on the central section. The strains in beams subjected to surface loading were thus shown to be of a character different from those usually assumed; the neutral axis, instead of coinciding with the axis of the beam, being lifted up in the centre, and its shape depending on the load and span. Other ingenious and interesting experiments on beams were described, in some of which the lines of principal stress were snapped out. Remarkable results were obtained, showing that although the tension lines given by Rankine and Airy are nearly correct, the curves of compression may be very different, and have very curious shapes. **Prof. Perry** thought the local loading effect would not be so important in long beams, and enquired whether, in ordinary test pieces, local loading would affect the breaking strength? He also asked what effect the fact of the load making contact over a surface, instead of along a line, would have on the results, and in reply, **Prof. Carus-Wilson** said the effect was to raise the asymptote of the hyperbola representing the surface loading stress, above the surface of the beam.

"**On Pocket Electrometers,**" by **C. V. Boys, F.R.S.** This communication described modifications of electrometers adapted for portability. As quartz fibres increase the delicacy and diminish the disturbing influences affecting instruments, much smaller controlling forces can be employed than when silk is used for suspensions. He had, he said, pointed out some time ago the great advantages arising from making galvanometers small. Applying similar reasoning to electrometers, he remarked that making an instrument one-tenth the size of an existing one reduced the moment of inertia of the needle to $\frac{1}{10^5}$, whilst the deflecting couple for given potentials would only be $\frac{1}{10}$ of its former value. The small instrument would for the same periodic time be 10,000 times more sensitive than the large one, provided the disturbing influences could be reduced in the same proportion. This, however, was not ordinarily possible, for any method of making contact with the needle, such as by a fine wire dipping into acid or mercury, prevented very small controlling forces being used. Still, by suitable devices, a large proportion of the full advantage could be obtained; a freely suspended needle without no liquid contacts was essential to success. The first instrument described was one in which the needle was cylindrical, contiguous quarters being insulated and connected to the opposite ends of a minute dry pile placed within the needle; opposite quarters were thus at the same potential, and at a different potential to the other pair of quarter cylinders. This was suspended within a glass tube silvered on the inside and divided into four parts by five longitudinal lines. In such an instrument the needle and quadrants are reciprocal, and the deflection depends on the product of the difference of potential between the quadrants and that between the parts of the needle. Owing to the dry pile not being constant, the instrument was found unreliable; but when working at its best, a Grove cell would give 30 mm. or 40 mm. deflection. The next step was to make a cross-shaped needle of zinc and platinum, and rely on contact electricity to keep the parts of the needle at different potentials. This bold experiment proved remarkably successful, for the instrument was very sensitive. A disc-shaped needle with quadrants alternately zinc and platinum was then employed, and by this a small fraction of a volt could be measured. The weight of the disc was only $\frac{1}{25}$th of a gramme, and the instrument could be turned upside down or carried about in the pocket with impunity. Another small instrument with the stationary quadrants of zinc and copper was exhibited, and by rotating them through an angle of 90deg., so as to bring them in a different position relative to the parts of the needle, a deflection of several degrees of arc was produced. In the course of his remarks Mr. Boys made several suggestions relating to ballistic electrometers and electrostatic Siemens dynamometers, and pointed out the possibility of instruments such as he had exhibited being of use in elucidating the obscure points in connection with so-called "contact electricity." The **President** complimented Mr. Boys on the beautifully simple and remarkably sensitive electrometers exhibited. He remembered that some years ago Mr. Gordon made a very small electrometer, but its insulation was insufficient for electrostatic work. He agreed with Mr. Boys as to the advantages of small instruments, providing sparking across or tilting of the needle could be prevented. On the other hand, he thought the use of small potential differences on the needle was a step in the wrong direction when great sensibility was required. **Prof. Perry** asked if the needle could not be kept charged by occasional contacts with a charged acid cup. **Mr. Boys** said he had originally intended using a fairly highly charged needle, but had not yet done so. He also suggested that an electrometer of very small capacity might be made by reducing the quadrants surrounding a disc needle until they became like small tuning forks.

A paper on "Electrification due to the Contact of Gases with Liquids," by Mr. J. Enright, B.Sc., and one on "The Expansion of Chlorine by Heat," by Dr. Arthur Richardson, were taken as read.

The following correction should be made in the report of the meeting on June 12th: For the first sentence in Mr. Blakesley's remarks on Dr. Lodge's experiments, substitute "Mr. Blakesley asked whether the pitch of the resonant jars altered when the distance between the circuits was varied, for according to theory the mutual induction should diminish the self-induction and cause the oscillations to be more rapid."

COMPANIES' MEETINGS.

NATIONAL TELEPHONE COMPANY.

The eleventh ordinary general meeting of this Company was held at Cannon-street Hotel on Thursday, Mr. F. R. Leyland (president) in the chair.

The report, which was published in our last issue, having been taken as read,

The **President** said that the net revenue account, notwithstanding the heavy reductions made in their rates in the provinces, still left them with an increased balance over last year, sufficient to pay the same rate of dividend on a much larger capital. They had carried the same amount to reserve as last year, and although they carried forward a little less, this was accounted for by an item in the revenue account of £1,388 estimated dividends from subsidiary companies which had not been received. In reference to the expense of the issue of debenture stock, the Directors decided, in view of the state of the money market, that it would not be a wise thing to take the risk of placing the whole amount, but that it would be wiser to underwrite a portion, and the cost of doing that was shown in the account, £8,053. The Company's business had gone on increasing since the 30th April, the date to which the accounts were made up. The gross revenue at that date stood at £418,560, and on the 30th June it had increased to £424,899. The number of subscribers had also increased from 35,440 on the 30th April to 36,655 on the 30th June. So that in spite of reductions in rates they had more than made up the loss in their annual revenue, but, of course, they had a great deal more work to do; more lines to keep in order; more operators to pay; and more capital on which to pay dividends, so that the problem still was, how far would this increase go on? He hoped, and thought the figures all pointed that way, that when he met them next year the increase would have gone on to such an extent as to provide for all extra expenses, and make their net revenue and profit just as good as it was then. They must not forget that this year's accounts had only felt the loss of January, February, March, and April—the remaining eight months would fall on next year. The point was whether the progressive increase would be enough to make up for that loss. It was perfectly clear the gross revenue would do so; the question was would the net result do so? As to improving the Company's system by changing the shackles and insulators, and substituting magneto for ordinary battery bells, that work had been gone on with, and they had done a third of it, as they had also of the rearrangement of the wires. Progress, they would understand, in this work must be small, as it had to be carried out while the ordinary service was going on; and there was another disadvantage, that with all the care they took they could not avoid contact between wires. That, of course, brought on them complaints from subscribers. In all his comparisons of revenue he had left out the South of England Company, because it was not included for the whole year. As to the re-election of the Directors (*vide* report) they had been very glad to take that opportunity—in fact, thought it their duty to do so—of placing themselves in the hands of the shareholders. They did so with the ciousness of having done all they could in carrying on a very cate and responsible business. He would be glad to answer questions.

r. **Harris** found fault with the Company's service, but declined pportion the blame, and other gentlemen asked questions as to accounts, Directors' fees, and so on, which were duly answered he **President**, who assured Mr. Harris that he would be only glad to personally attend to any complaints if they were e direct to him.

he **President** then moved that the report and accounts be oted, and the dividend (*vide* report) be declared, which was onded by **Mr. J. Staats Forbes**, and carried unanimously.

ubsequently the President vacated the chair, and was duly lected with many flattering allusions to his ability and energy, also were the vice-presidents, Mr. J. S. Forbes and Colonel kson, and the whole of the Directors, the names being put *rtim.*

he **President** said that he proposed to fill up one of the two vincial vacancies on their Board by the election of Mr. William xander Smith.

his was seconded by **Colonel Jackson** and carried unanimously. he auditors, Messrs. Welton, Jones, and Co., were then re-ted, and the proceedings closed.

NDIA RUBBER, GUTTA PERCHA, AND TELEGRAPH WORKS COMPANY.

half-yearly meeting of this Company was held at Cannon-eet Hotel on Thursday, when the sanction of the shareholders s obtained to the payment of an interim dividend of 5 per cent., 10s. per share, free of income tax.

COMPANIES' REPORTS.

CHILI TELEPHONE COMPANY.

The report of the Directors to March 31, 1891, states that the tion in the Chilian Court between the vendor American company d a small minority of its shareholders was ready for decision, ien, by order of the Government, the courts were all closed, and ey have not since been reopened; as, consequently, the impediment to registration of the Company's title has not yet been moved, the business of the Company is continued in the name of e vendor company, but without serious damage to this Company's interests. After the outbreak of the civil war the business the Company was stopped by order of the Government, which s since had the entire use of those of the Company's lines situed within the districts remaining under its control; but business s been resumed for the public at Iquique and other stations in stricts held by the Congress party. On March 31, when e present account ended, the public service at Santiago had en suspended for one month and 18 days. For the loss of business e Government will compensate the Company, and 62,000dols. d, on March 31, been received on account of such compensation. he Company's property has sustained damage only in the province Tarapaca. After all deductions are made the balance available r dividend is equal to 7 per cent. per annum upon the paid-up pital, as against a distribution of 5 per cent. for the previous ear. In view, however, of the continuation of the civil war—ith very indefinite prospects of its ending—and also in view of e fact that, for capital purposes, it has been necessary to use, temorarily, the income of the Company until the capital exchequer e replenished by further issue of securities—which cannot be one on satisfactory terms at the present time—the Directors ecommend that no dividend be paid, carrying forward, undivided, e whole balance of £14,210 until peace is re-established.

NEW COMPANIES REGISTERED.

City of Waterford Electric Supply Company, Limited.—Registered by H. F. Kite, 11, Queen Victoria-street, E.C., with a apital of £1,000 in £5 shares. The object of this Company is ufficiently indicated by the title. Registered without articles of ssociation.

County of London Electric Lighting Company, Limited.—Registered by Sydney Morse, 4, Fenchurch-avenue, E.C., with a apital of £100,000 in £5 shares. Object: to carry on the business f electricians and electrical engineers in all its branches. The irst subscribers are:

	Shares.
I. A. Kelman, 251, Winchester House, E.C.	1
J. C. Bull, 1 and 2, Great Winchester-street, E.C.	1
E. Garcke, 112, Belvedere-road, Lambeth, S.E.	1
B. H. Van Tromp, 4, Hyde Park terrace, W.	1
B. Broadhurst, 112, Belvedere-road	1
G. Parker, 20, Bucklersbury	1
T. Cooke, Winchester House	1

There shall not be less than three nor more than seven Directors; the first are the signatories to the memorandum of association. Qualification, one share. Remuneration to be determined in general meeting.

Hampstead Electric Light and Power Supply, Limited.—Registered by R. M'A. Inglis, 5, Victoria-street, S.W., with a capital of £1,000 in £1 shares. The objects of this Company are sufficiently indicated by the title. With slight modifications, the regulations contained in Table A apply.

International Inventions Corporation, Limited.—Registered by P. J. Rawlings, Avenue-road, New Southgate, N., with a capital of £100,000 in £1 shares. Object: to carry on business as bankers and capitalists, and also as civil, mechanical, and electrical engineers, etc. The first subscribers are:

	Shares.
W. T. Prestoe, 32, Woodstock-road, Hornsey, N.	1
P. J. Rawlings, Avenue-road, New Southgate, N.	1
T. Baker, 6, Mount Pleasant-road, Lewisham, S.E.	1
E. T. Clarke, 51, Milkwood-road, Herne-hill, S.E.	1
H. A. Pinchbeck, 71, Queen-street, E.C.	1
W. E. C. Pinchbeck, 71, Queen-street, E.C.	1
J. Chinn, 1, Oakden-street, Kennington-road, S.E.	1

There shall not be less than three nor more than nine Directors The first shall be the first signatories to the memorandum of association. Qualification, 50 ordinary shares. Remuneration, Chairman, £250 per annum; ordinary Directors, £150 each per annum.

South American Cable Company, Limited.—Registered by Wilson, Bristowe, and Carpmael, 1, Copthall-buildings, E.C., with a capital of £500,000 in £10 shares. The objects of the Company are the establishing, maintaining and working of telegraphs, telegraphic, telephonic, or other communication, as well overland as submarine, from, in, and between South America, Africa, Europe, and islands or places in the Atlantic Ocean, or any of them. The first subscribers are:

	Shares.
A. Scott, 149, Leadenhall-street, E.C.	1
H. Marsham, 28, Bury-street, St. James's	1
J. W. Silver, Letcount Manor, Wantage	1
R. Henderson, 7, Mincing-lane	1
R. K. Gray, 106, Cannon-street, E.C.	1
M. Gray, Lessness Park, Abbey Wood, Kent	1
A. W. Jarvis, M.P., 120, Mount-street, W.	1

There shall not be less than three nor more than seven Directors; the first shall be appointed by the signatories to the memorandum of association. Qualification, £500. Remuneration, £1,200 per annum, with a further 5 per cent. on the surplus profits after 6 per cent. dividend, the same to be divisible.

St. John, Hampstead, Electric Supply Company, Limited.—Registered by H. F. Kite, 11, Queen Victoria-street, E.C., with a capital of £1,000 in £5 shares. The object of this Company is sufficiently indicated by the title. Registered without articles of association.

CITY NOTES.

The Telegraph Construction Company announces a dividend of 12s. per share.

Brazilian Submarine Telegraph Company.—The receipts for last week were £5,028.

City and South London Railway.—The receipts for the week ending July 4th were £719, against £697 for the week ending June 27th.

Eastern Extension Telegraph Company.—The receipts for June were £39,749, against £43,198 for the corresponding period of 1890.

Traffic Receipts.—The Eastern Telegraph Company's receipts for the month of June were £52,341, against £51,019 in the corresponding period of 1890.

Cuba Submarine Telegraph Company.—The estimated receipts for the month of June were £3,500, as compared with £3,324 in the corresponding month of last year.

Great Northern Telegraph Company.—The receipts for June were £27,400, making the total since January 1st £141,400, against £130,400 in the corresponding period of 1890, and £129,400 in 1889.

Western and Brazilian Telegraph Company.—The receipts for the week ended July 3, after deducting 17 per cent. of the gross receipts payable to the London Platino Company, were £3,563.

West Coast of America Telegraph Company.—The receipts for the month of March were £3,250, for April £600, for May £1,275, and for June £1,575. The southern cables are still interrupted, owing to the revolution in Chili.

West India and Panama Telegraph Company.—The estimated receipts for the half-month ended the 15th June are £2,491, as compared with £3,186 in the corresponding period of 1890; and for the half-month ended 30th June £2,264, compared with £3,242.

Wyndham Electric Light Company, Limited.—Registered by Drake, Driver, and Leaver, 13, New Bridge-street, E.C., with a capital of £1,500 in £1 shares. Object: the public and private lighting of the village of Blaenrhondda by electricity. Registered without articles of association.

Direct United States Cable Company.—The Directors have resolved to recommend a final dividend of 3s. 6d. per share, free of income tax; such dividend to be payable on and after the 24th inst., making, with the interim dividends already paid, 3½ per cent. for the year ending 30th June last, carrying forward a balance of £3,502. 1s.

St. James's and Pall Mall Company.—The receipts of the Company for current sold during the quarter ending June 30 amounted to £6,632, as against £1,991 in the corresponding period of last year. The amount received for the quarter ending March 31 was £9,652, against £1,818 for the corresponding period of last year. The falling-off in last quarter's receipts as compared with those for the first quarter of the year is, of course, to be attributed to the longer hours of daylight, and the consequent decrease in the demand for artificial light.

Eastern Telegraph Company.—Subject to final audit, the accounts of the Company show, after placing about £95,000 to reserve fund, a balance available sufficient to pay at the general meeting on the 16th inst. the fixed dividend of 3s. per share, being at the rate of 6 per cent. per annum on the preference shares, less income tax; and a final payment of 2s. 6d. with a bonus of 3s., both free of income tax, on the ordinary shares, making with previous payments a total distribution of 6½ per cent. on those shares for the year ended March 31 last. The Company's transfer-books will be closed until the 16th inst.

Edison-Swan Company.—The accounts of this Company for the year ending June 30, 1891, having been made up, the Directors have resolved, subject to audit, to recommend the shareholders to declare a dividend at the rate of 7 per cent. per annum for the six months ending June 30, 1891, making, with the interim dividend paid in February last, 7 per cent. for the year, and a further dividend of 10 per cent. in respect of the arrears of cumulative preferential dividend, to be distributed in accordance with the articles of association. The dividend will be paid upon the register as it stood on the 7th inst., and the dividend warrants will be issued on the 30th inst.

Companies of the Month.—The following companies were registered during June:

	Capital.
Albert Electric Lighting Company, Limited, £5 shares	£10,000
Bournemouth and District Electric Supply Company, Limited, £5 shares	50,000
Babcock and Wilcox, Limited, £10 shares	240,000
County of London Electric Lighting Company, Limited, £5 shares	100,000
Electrolytic Caustic Soda and Chlorine Trust, Limited, £10 shares	10,000
Gloucester Electricity Supply Company, Limited, £1 shares	100
Hampstead Electric Light and Power Supply, Limited, £1 shares	1,000
International Inventions Corporation, Limited, £1 shares	100,000
Middlesbrough Electricity Supply Company, Limited, £1 shares	100
Ogmore Valley Electric Light and Power Supply Company, Limited, £5 shares	10,000
Queen Anne's-mansions Lighting and Heating Company, Limited, £10 shares	60,000
Rochdale Electricity Supply Company, Limited, £1 shares	100
Stoke-upon-Trent Electricity Supply Company, £1 shares	100

PROVISIONAL PATENTS, 1891.

JUNE 29.

11016. **Improvements in armatures of dynamo-electric machines and electric motors.** Hugh Longbourne Callendar, 2, Prince's-mansions, Victoria-street, London.

11048. **Improvements in the preparation and laying of electrical mains on the Brooks system.** Walter Claude Johnson and Samuel Edward Phillips, 28, Southampton-buildings, London.

JUNE 30.

11060. **Improvements in thermo-electric batteries.** Paul Giraud, 52, Chancery-lane, London.

11075. **Electric meters.** Benjamin Joseph Barnard Mills, 23, Southampton-buildings, London. (Herbert Morris Pilkington and Roger Sherman White, United States.)

11082. **An improved telephone combination.** Sir Charles Stewart Forbes, 21, Finsbury-pavement, London.

11093. **A simple device for detecting a leakage to earth, principally adapted to isolated electric light installations.** Wallace J. Sandy and William A. Easter, 41, Choumert-road, Peckham, London.

11108. **Improvements in and connected with electric primary batteries.** Theophilus Coad, 1, Quality-court, London.

11113. **Improvements relating to electromotors, and to the transformation and distribution of electric currents.** Friedrich Wilhelm Lahmeyer, 433, Strand, London.

11118. **Improvements in electrical signals for steam vessels and analogous purposes.** Alexander Melville Clark, 53, Chancery-lane, London. (Edwin Warren Tucker and Leopold Katzenstein, United States.) (Complete specification.)

11120. **Improved leading-in wires or conductors for incandescent electric lamps and the like.** Reginald Aubrey Fessenden, 45, Southampton-buildings, London. (Date applied for under Patents Act 1883, Section 103, 18th February, 1891, being date of application in United States.)

11133. **Improvements relating to dynamo-electric machines and electric motors, and to apparatus connected therewith.** Henry Harris Lake, 45, Southampton-buildings, London. (The Crocker-Wheeler Electric Motor Company, United States.) (Complete specification.)

11134. **Improvements in apparatus for the electrolysis of aluminium.** Camille Alphonse Faure, 46, Lincoln's-inn-fields, London.

11144. **Improvements in printing telegraphs.** Henry Van Hoevenbergh, 47, Lincoln's-inn-fields, London.

11145. **Improvements in and connected with printing telegraph instruments.** David Homer Bates and Henry Van Hoevenbergh, 47, Lincoln's-inn-fields, London. (Complete specification.)

11149. **A multiple filament electric incandescent lamp.** Emile Guitton, 166, Fleet-street, London. (Ad. Collett, France.)

JULY 1.

11157. **Improvements in transmitters and receivers for telephones.** James Radcliffe and James Ernest Spagnoletti, 2, Great George-street, Westminster, London.

11181. **Improvements in electric switches.** Henry Alexander Mavor, William Arthur Coulson, Sam Mavor, and William Brooks Sayers, 62, St. Vincent-street, Glasgow.

11201. **Improvements in apparatus for telephonic communication.** Joseph Sack, Emil von Maltitz, and Peter Ziesol, 433, Strand, London. (Complete specification.)

11211. **Improvements in interrupters for strong electric currents.** Martin Kallman and The Company Allgemeine Elektricitats Gesellschaft, 47, Lincoln's-inn-fields, London.

JULY 2.

11225. **The improvement of production of electricity by means of a dry cell battery.** Francis Joseph Robman, 40, Berners-street, London.

11278. **Improvements in the production of elements for electric or secondary batteries.** Emmanuel Hancock and Augustus John Marquand, 24, Southampton-buildings, London.

JULY 3.

11294. **An improved system of telephonic exchange signalling.** Alfred Rosling Bennett, 22, St. Albans-road, Harlesden, London.

11301. **Improvements in or relating to driving electric current generators for lighting steamships and railway trains, and for other purposes, and in apparatus therefor.** Paul Raoul de Faucheux d'Humy, 6, Lord-street, Liverpool.

11313. **Improvements in means or apparatus for utilising electrical energy in operating rock boring and other mechanism.** Reginald Bolton, 55, Chancery-lane, London.

JULY 4.

11384. **An improved electric igniting device applicable for use in motor engines operated by the combustion of vapours or gaseous hydrocarbon.** William Dent Priestman and Samuel Priestman, 191, Fleet-street, London. (R. B. Elwell, Australia.)

11407. **An improved thermo-electric meter.** Frederick William Cannon, 166, Fleet-street, London.

SPECIFICATIONS PUBLISHED.

1884.

12445. **Telephonic systems.** Crossley and others. (Second edition.) 6d.

1889.

17060. **Electrical furnaces.** Parker. (Second edition.) 8d.

1890.

9212. **Utilising electromotors for elevating, etc.** Statter and Brunton. 6d.

9246. **Electromagnetic separator.** Ronczewski. 8d.

12383. **Electric lamps.** Shepard. 8d.

12504. **Incandescent electric lamps.** Allam. 6d.

12763. **Electrical batteries.** Buffet. 4d.

1891.

2866. **Electrical measuring instruments.** Lake (Weston). 8d.

4099. **Electric arc lamps.** Akester. 8d.

5067. **Economic, etc., telegraphing.** Lassen. 8d.

7970. **Distributing electric energy.** Wahlmstrom. 6d.

8034. **Electrical conductors.** Shepard. 8d.

8136. **Electric car motors.** Christiansen. 8d.

8163. **Electric railways.** Dewey. 8d.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Brush Co.	—	2¼
— Pref.	—	1⅝
India Rubber, Gutta Percha & Telegraph Co.	10	19½
House-to-House	5	5
Metropolitan Electric Supply	—	10
London Electric Supply	5	2
Swan United	3½	4½
St. James'	—	7
National Telephone	5	5
Electric Construction	10	7¼
Westminster Electric	—	5

NOTES.

Stock Exchange.—Telephonic communication is now open between the London and the Manchester Stock Exchange.

Price of Current.—At Saint-Brieuc the hecto watt-hour (100 watt-hour) is sold at ·7d. This is stated to be the lowest in France.

Bridlington.—New Local Board offices are to be built at Bridlington. It will probably mean a job for electrical engineers as well.

Translations.—The French Bibliothèque Nationale has opened a register of persons capable of translating scientific works into any tongue.

Electric Bus in Paris.—*Electricité* chronicles the appearance of a waggon drawn at considerable speed by electricity in the streets of Paris.

Overhead Wires.—At the London County Council mention was made that the London Overhead Wires Bill received Royal assent on 3rd inst.

Miners' Lamps.—The Renard chloro-chromic battery is being applied to miners' lamps, the weight being the same as the ordinary safety lamp.

Continental Electric Railways.—The Allgemeine Company of Berlin are to construct two electric tramway lines on the Sprague system at Stockholm and at Kiew.

Calcutta.—A new departure is to be made in street lighting at Calcutta. The Corporation are advertising for tenders for lighting the new Central-road with electricity.

Taunton Exhibition.—Field-Marshal Sir J. Lintorn Simmons has consented to open the electrical appliances and electric light exhibition to be held in Taunton shortly.

Accumulators for Sweden.—It is announced that the Swedish excise authorities have declared accumulators to be scientific instruments and allow them to enter duty free.

Electric Tricyles.—One of the most influential companies of Paris, says the *Bulletin de l'Electricité*, is experimenting with electric tricyles, and something further will probably soon be heard.

Chelsea.—The Vestry of Chelsea have presented a petition against the recommitment of the Electric Lighting Provisional Order Confirmation Bill, dealing with the parish of St. Luke, Chelsea.

Helston.—At a special meeting of the Town Council on Monday Mr. Veale, of St. Austell, gave details of the cost of lighting the town electrically. He is to give an estimate and confer with a committee on the matter.

Electrolytical Analysis.—The method of chemical analysis by electrolysis is spreading. A special installation of accumulators has been made, says the *Bulletin de l'Electricité*, for this purpose in the Ecole Normale Superieure of Paris.

Greenwich Observatory.—The Astronomer-Royal considers it desirable a complete installation of electric light should be adopted at the Royal Observatory. The lighting is now done by a number of Pitkin batteries and lamps.

City and Southwark Subway.—A long and interesting account of the English triumph in the electric subterranean railway to Stockwell has been given by the *Etoile Belge*, which is reproduced in *L'Ingenieur Conseil* for 12th July.

Telephones for Cardiff.—The Cardiff Town Council have resolved, on the motion of the chairman, that an estimate of the cost of establishing telephonic communication between the Bute Docks and the central police station be obtained.

Fribourg.—Water power is used at Fribourg for turbines driving dynamos direct for lighting and power. The current is distributed at the rate of ·1d. per horse-power hour over 20 h.p.; ·12d. from 5 h.p. to 20 h.p.; and ·15 for less than 5 h.p.

Richmond Town Hall.—Municipal buildings are to be erected at Richmond to designs by Mr. H. J. Ancell, architect, 3, Staple-inn, London. They should be wired ready for electric light. The tenders are to be sent in by August 4 to the town clerk, Richmond.

Paris.—The Creuzot Works have received the contract to install the electric light in the Gare d'Orleans at Paris. The Ganz system will be used. Sixty lamps of 25 to 40 carcels, and two of 250 carcels, are also being installed by another firm in the Gare Montparnasse.

Continental Telegraphs.—In the Lower House of the Austrian Diet, the Marquis von Bacquehem, Minister of Commerce, stated that there was a prospect of the establishment in the course of the year of a direct telegraph line connecting Vienna, Munich, Paris, and London.

Personal.—Mr. E. Manville, M.Inst.E.E., writing to us from Albany-buildings, 39, Victoria-street, Westminster, notifies us that he has severed his connection with manufacturing companies, and is now carrying on exclusively the profession of consulting electrical engineer at the above address.

"Journal."—The *Journal* of the Institution, part 94, has appeared, and contains Dr. Fleming's, Mr. Preece's, and Mr. Crompton's contributions to the science of electrical mains, with discussions thereon, with also classified list of articles on electrical subjects and abstracts from the foreign journals.

Glasgow.—As will be seen from their advertisement, the Glasgow Corporation are desirous of securing a competent electrical engineer. The situation is an important one, and the salary will commence at a minimum of £250 a year, the engineer's whole time and attention to be given.

Electrical Units.—At the ensuing British Association meeting at Cardiff, it is proposed to hold in Section A, if possible in conjunction with Section G, a discussion on "Units and their Nomenclature," having special regard to the new electrical and magnetic units now becoming necessary for practical purposes.

Society of Arts.—The council of the Society of Arts have been asked by the Government to undertake the duty of organising the British section at the Chicago Exhibition in 1893, and are to be constituted a Royal Commission for that purpose. The formal documents constituting the commission will be issued very shortly.

Obituary.—Dr. William Henry Stone, consulting physician to St. Thomas's Hospital, died last week at his residence, Geraldine-road, Wandsworth, in the 62nd year of his age. Dr. Stone was very well known in electrical circles from his attention to questions of electricity in physiological science, and especially to that of the electrical resistance of the human body.

Canterbury.—At the meeting of the Canterbury General Purposes Committee last week, the Mayor mentioned that the Dover Corporation intended inviting contracts from the different companies to take over the provisional order; they would thus see which company offered the best terms. He did not think they could do better than follow their example.

Technical Institute at New Cross.—The Goldsmiths' Company are instituting a new technical and recreative institute at New Cross. Many technical classes will be held. That for electrical science will be under Mr. W. Slingo, A.I.E.E., principal of the Telegraphists' Central School of Science, his assistant being Mr. A. Brooker. The fees will be 7s. 6d. a session.

Aylesbury.—Tenders are invited for lighting the several public lamps and clock tower within the district of the Aylesbury Local Board, for one year from August 1st. The conditions for lighting, and all other particulars in connection therewith, may be obtained on application to Mr. George Fell, clerk, Aylesbury, to whom tenders must be sent by 31st inst. Electricity is not specially mentioned.

Overhead Wires at Dulwich.—The Camberwell Vestry have been much exercised with reference to overhead fire alarm wires. The Vestry wished to have them underground, but the London County Council would not sanction the expense—£29 instead of £18. This raised a stormy discussion, and the committee recommended that the London County Council be informed that the Vestry required the wires to be laid underground.

Electric Ventilators for War Vessels.—We learn that Messrs. Shippey Bros., of London, have secured the contract for fitting the new war-ships now being built in France for the Chilian Government with their large-size standard electric blowers. The method of ventilation will be the same as that which has so successfully worked on the s.s. "Baltimore" and other vessels, illustrations of which were given in our issue of April 25, 1890.

Holbeach.—The Local Board of Holbeach have been considering the question of whether they should use oil or gas for lighting the streets. During the past two years, by means of oil, they have effected a saving of 25 to 30 per cent. The tender for lighting by means of oil was again accepted. A member of the Board declared that it was a disgrace to the town to adopt such a course, and he said they were laughed at by visitors. He evidently wanted electric light.

Carshalton.—At the meeting of the Carshalton Local Board last week the clerk reported that he had only received one tender for lighting—namely, Messrs. Defries and Co.—offering to light the parish for 60s. per lamp per annum. No tender had been received from the gas company. The matter was adjourned, Mr. Taylor saying he was in favour of the electric light, and Mr. Sheppy likewise remarked that he agreed—they ought to move with the times.

City and South London Railway.—The suit of the London County Council against the City and South London Railway for infringement of building limit was not allowed and their appeal failed, it being held that words in the special Act, "as may be required for the purpose," implied that the railway company were to be the judges of what they would require. The Court having found that a station was necessary, there was no authority for compelling the company to build their station on any particular spot.

Salford.—Tenders are required for lighting the Ladywell Sanatorium by an electric light installation, for the county borough of Salford. Applications for specifications, accompanied by a deposit of £1. 1s. (which will be returned upon receipt of a *bonâ fide* tender), to be made to Messrs. Maxwell and Tuke, or Messrs. E. and F. Hewitt, architects, Manchester. Tenders, endorsed "Electric Lighting," addressed to the Chairman of the General Health Committee, must be delivered to Mr. Samuel Brown, town clerk, Town Hall, Salford, by 11 a.m. on 30th inst.

Reigate.—There has been a dispute in Reigate about the terms asked by the Redhill Gas Company. The company declined £3. 3s. per lamp offered by the Council, and the committee advised the invitation of tenders for electric lighting. There had been, however, no time for this till the expiration of the gas contract, and the Council determined to agree to the gas company's terms. The cost of gas is £1,800 a year, and there will probably be a feeling in favour of the consideration of electric light next year.

Central London Railway Bill.—With reference to the Central London Railway Bill, which is now before a Select Committee of the House of Lords, it was recommended and resolved by the Hammersmith Vestry at their last meeting, that in view of the many advantages of speedy transit and communication which the proposed railway will confer upon the northern portion of Hammersmith, and also having regard to the protective clauses and amendments which the promoters inserted at the instance of the Vestry, that the Vestry present a petition to the House of Lords in favour of the Bill.

Mutual Telephone Company.—Four hundred and seventy subscribers are now in communication through the Mutual Exchange at Manchester, and 500 will be joined by July 22. By the end of August 700 will be speaking. On July 31 the replacing of the present temporary transmitters by loud-speaking carbon ones will be commenced, and finished in about 10 days. At June 30 the Mutual Company's Manchester system comprised 421 miles of wire used as metallic circuit, in use, 150 miles of the same spare, 11 miles of single wire, 90 standards, 14 poles, 81 cables, 134 junction-boxes, and attachments to 430 buildings.

Motors for the City.—It was reported at the meeting of the Commissioners of Sewers last week, that notices had been received from the Brush Electrical Engineering Company of their intention to apply in the next session of Parliament for a provisional order authorising them to supply electrical energy for any public or private purposes within the City of London, and from the Laing, Wharton, and Down Construction Syndicate, of their intention to apply in the next session of Parliament for a provisional order authorising the said syndicate to amend the City of London (East District) Electric Lighting Order, 1890. These were referred to the Streets Committee.

Edison Lamp Patents.—The case brought by the Edison Electric Light Company against the United States Electric Light Company (owned by the Westinghouse Company), for the infringement of one of the patents belonging to the plaintiffs was decided on Tuesday in New York. Judge Wallace, of the United States Circuit Court, gave judgment, sustaining Edison's patent on the incandescent electric lamp. He also gave orders for an injunction against the defendant company, and for a return giving an account of the profits for the past manufacture of such lamps. The patent was sustained by the English Courts, with the decisions of which Judge Wallace's judgment apparently agrees.

Cork.—At the meeting of the Cork Corporation last week, the town clerk said with reference to the notice of intended applications to the Board of Trade by the Cork Gas Consumers' Company for a provisional order under the Electric Lighting Acts, to authorise the company to supply electrical energy within the municipal borough, and to take all needful action in respect of same as indicated by said Acts, it was necessary for the Council to fix a special day to consider the question at a month's notice. He would himself bring up a report on the matter. Alderman Scott proposed that the fixing of the date be left to the town clerk, and said the Corporation should not allow the lighting of the city to be taken out of their hands again. The proposition was agreed to.

City Lighting.—The Streets Committee of the Commissioners of Sewers have reported that a notice had been received from the Brush Electrical Engineering Company of their intention to lay a line of main conductors under the footway of both the north and south sides of Cannon-street, from Walbrook to and including the south side of St. Paul's-churchyard, and a line of main conductors from Queen Victoria-street, through Bucklersbury to the junction-box by the Mansion House, and the committee recommended that consent should be given, subject to the provisional order, and that the committee be empowered to give the necessary sanction, from time to time, for the different sections of the work of City electric lighting, subject to the contracts and provisional orders.

The World's Fair.—It is probable that the Chicago Exposition will be open in the evenings, in all its departments. Plans and estimates have been invited for lighting by electricity all of the buildings. It is proposed to light both the buildings and grounds so brilliantly that everything can be seen at night as well as by day, and it is expected that the scene at night will be one of marvellous brilliancy. United States Attorney-General Miller has rendered a decision that will be of great interest to foreign exhibitors. It is to the effect that these exhibitors can bring with them enough employés to show the process of manufacturing the goods they display without being held for violation of the contract labour law. The decision was rendered at the request of the French Consul in Chicago, who represented that many manufacturers in France would not take part in the fair unless they could bring with them a limited number of employés. The Chicago Exhibition authorities have already received 1,000 applications for space.

Athletic Sports.—Mr. Ronald A. Scott, M.I.E.E., M.R.I., etc., the well-known electrical engineer, evidently vies with his brother, Commander Percy Scott, R.N., in getting up athletic meetings, and notwithstanding the counter attractions of the Royal review and the Eton and Harrow match, nearly 500 visitors responded to the invitation on Saturday last, and evidently thoroughly enjoyed themselves in the grounds, some 20 acres in extent, which surround Mr. Scott's residence, "The Elms," Acton-hill, W., so well known to travellers along the Uxbridge-road. There were 16 events, all well carried out; but the final one, walking the greasy pole over the lake, was certainly exciting and caused roars of laughter, whilst it brought out some splendid exhibitions of swimming. At last, after many futile attempts and consequent duckings, General Rich's son made a rush for it and succeeded in picking off the flag during his somewhat comical descent into the water. All the competitors were members of the Acton-hill Electric Engineering Works.

City Electric Lighting Company.—The new company for taking over the contracts and concessions for the electric lighting of the City has been brought out this week, under the name of the City of London Electric Lighting Company, Limited, with a capital of £800,000 in 40,000 preference and 40,000 ordinary shares of £10 each, of which the ordinary shares are now issued. The directors are Sir David Salomons, Bart., chairman, Edward Lucas, Esq. (of Messrs. Lucas, Michells, and Co.), F. W. Reynolds, Esq. (of Messrs. F. W. Reynolds and Co.), the Duke of Marlborough (chairman of the Electric and General Investment Company, and of the Brush Electrical Engineering Company), the Earl of Suffolk and Berkshire, Hon. Alan Charteris (Lloyds, E.C.), J. Bevan Braithwaite, jun., Esq. (director of the Electric and General Investment Company, and of the Brush Electrical Engineering Company). Chief engineer, Major-General C. E. Webber, C.B., past-president of the Institution of Electrical Engineers. Secretary, J. Cecil Bull, Esq. Offices, 1 and 2, Great Winchester-street, E.C.

The German Emperor's Palace.—It will not be without interest at this juncture to read the details of the electric installation at the Royal Palace at Berlin. Hitherto the illumination has been by candles, no gas having been admitted. The whole has recently been fitted with electric light. The plant consists of two engines, of 150 h.p. and 50 h.p. Space is arranged for two others of 200 h.p. each. There are two dynamos—a four-pole machine driven by the smaller engine, and a six pole machine of 100,000 watts, coupled to the 150-h.p. engine. When finished, the total present capacity will be 360,000 watts, with a battery of 860 ampere-hours capacity. In the Imperial chambers there are 557 lamps of 10 c.p. to 25 c.p. The corridors contain 152 incandescent lamps, and offices 133 lamps. The gateways have nine arc lamps of six amperes. The ballrooms and drawing-rooms have in all 1,960 incandescent lamps, of which over 1,000 are in the great White-room. A number of motors are also used. It is expected that two other Siemens dynamos will be installed with a further battery of 800 ampere-hours.

Telephone Clauses in the Electric Lighting Acts.—At a recent meeting of the Electric Trade Section of the London Chamber of Commerce, the secretary of the Chamber stated that they had approached the Board of Trade on the question of telephone clauses in the Electric Lighting Acts, but the reply was considered so unsatisfactory that the idea of sending an influential deputation was abandoned. We learn now, that although it was not communicated to the secretary of the Chamber, that the Board of Trade had evidently thought better of it, and subsequently altered the provisional orders by inserting those clauses for the protection of the telephone company desired by the Chamber of Commerce, in lieu of those previously inserted in the orders. It is believed that the action of the Chamber has in no small degree contributed to the satisfactory result, and we would hope that the same body may now be able to achieve an equally satisfactory result in regard to the "overhead wires" question; action in regard to which we believe was only delayed in consequence of the unsatisfactory reply already referred to.

Tenders for Bradford Town Hall.—The Finance Committee of the Bradford Town Council have recommended that the Council should accept the tender of Mr. Wilson Hartnell for the providing and fixing of fittings required in the lighting by electricity of rooms in the municipal buildings, for the sum of £630. Mr. James Pratt asked why it was that the committee had not advertised for tenders, and why, if they thought it expedient to advertise, they had not seen their way to let the contract to a Bradford firm. Mr. S. Robinson suggested that the question should be allowed to remain over. Alderman F. Priestman said that he believed the course taken by the committee was to select six or eight firms who were thought suitable, and invite them to tender for the work to be done. The tenders in the present instance were in the room, and the committee, after going carefully over the matter, accepted the lowest one. Mr. Oddy accepted the suggestion made by Mr. Robinson as to allowing the resolution in reference to the electric lighting of the Town Hall to stand over for the present. This part of the resolution was therefore withdrawn.

British Association at Cardiff.—Another meeting of the Cardiff Committee of the British Association was held on Monday night in the Town Hall. Mr. T. Webber presided over an attendance which comprised Messrs. S. Jones, C. Jones, W. H. Allen, and Mr. R. W. A. Atkinson and Prof. Tanner (joint hon. secretaries), and Mr. S. W. Arnold (assistant secretary). Prof. Tanner reported with reference to the proposed lecture for working-men to be delivered during the British Association week, that a lecture to working-men had been given every year since 1867, except on two occasions. It would depend upon the extent of support given by working-men of the town and district as to whether the lecture would be delivered. If any surplus remained, it would go to a local charity. Prof. Silvanus Thompson had been invited to be the lecturer, and the subject he had chosen was "Electricity in Mining," a subject of considerable interest, and one which ought to draw a lot of people from the valleys. Dr. Thompson would show many experiments. On the motion of Mr. Jones, seconded by Mr. Allen, it was resolved to make arrangements for the lecture being delivered in Wood-street Chapel on August 22. It was decided to enlist the support of both employers and employed in connection with the matter.

Oyonnax.—The Compagnie Lyonnaise d'Electricité ordered of MM. Cuenod, Sautter, et Cie., of Geneva, the plant for an important installation for transmission of power to Oyonnax (Ain), of which the following particulars are given: The motive power is furnished by a fall of the Oigrim, a tributary of the Ain, of 60ft. head, and yielding a possible force of 1,750 h.p. The generating station consists of two groups, each comprising a horizontal turbine coupled direct to a Thury dynamo of 150 h.p., giving at 350 revolutions 105,000 watts at 2,000 volts; these two dynamos are coupled in series. The line is five miles long: it is formed of three wires, two of 6·5 mm. and the other of 4·5 mm. diameter; the loss along the line is reckoned at 10 per cent. Two motors of 120 h.p. coupled in series receive current at 1,800 volts; these drive direct two secondary dynamos, giving 600 amperes at 125 volts. This current is to be used for the distribution of light and power in the town of Oyonnax by means of a three-wire distribution. The tests made have shown a total efficiency of 76·2 per cent. The installation has been in regular work since March, 1890, and has not ceased to run with the greatest regularity ever since, in spite of the extreme cold of the late winter, which stopped without exception all the hydraulic installations in the neighbourhood.

Electric Tramways for Walsall.—The General Purposes Committee of the Walsall Town Council on Monday reported that they had considered the report of Mr. F. Brown, of the Walsall Electrical Company, upon his recent enquiries in America as to the working of tramway lines there with electric motors to be supplied with electricity by means of overhead wires. They recommended that, subject to arrangements being made by the company to the satisfaction of the committee as to the terms and conditions upon which poles shall be placed in the public streets, and overhead wires shall be carried along and across such streets, and cars run on the tramways by electricity, the consent of the Council be given to the company working these lines by means of overhead wires, and that the committee be authorised to employ an electrician to advise them as to the conditions and terms to be imposed upon the company. Alderman Evans proposed the adoption of the recommendation, and stated that Mr. Brown was completely satisfied with what he saw in America, and the fact that town after town, to the extent of hundreds, had adopted the system. Mr. Powell seconded the proposition, giving particulars of the proposed arrangements. Dr. Stead was fearful that there would be great danger to life and limb from the introduction. Alderman Holden objected to Walsall being the first place in the kingdom to try the experiment. The chairman and others supported the motion, which was finally carried by 15 to 5.

Catalogue.—Messrs. Ernest Scott and Mountain have forwarded to us a copy of their catalogue of electrical apparatus for electric light, electroplating, and transmission of power—a neat book of 144 pages, containing many illustrations and a vast amount of special and incidental information, with a complete index. The book deals first of all with the advantages of electric light, and gives specimen installations and their approximate cost. The Tyne dynamo is illustrated and fully described, with special stress laid upon such matters as are likely to arise in erecting and running the plant. Tables are given showing the hours of necessary lighting throughout a year of 8,760 hours—sundown to various hours up to midnight, or 2 a.m. or 4 a.m., etc. The question of alternating dynamos and transformers is given a separate chapter. Arc lamps of various kinds are dealt with, and tables of prices, carbons, and candle-power are given. Projectors, Admiralty switches, cut-outs, and all other necessary apparatus are described, special attention having been given to ship fittings. Wiring tables through various qualities of insulation show insulation resistance, size and prices, and very careful instructions are given for jointing cables. Accumulators are also dealt with in a similar way, with complete instructions for their management. Telephones, steam and gas engines, and turbines are also illustrated. Altogether this catalogue makes an interesting and useful work of reference to electrical contractors and authorities.

Chislehurst.—At a meeting of the Chislehurst local authority, on Monday, the deputy clerk read a letter from the Provincial Electric Lighting Power Supply Company, Limited, of 5, Queen Victoria-street, notifying their intention of applying for a provisional order for supplying electricity in the parish of Chislehurst. The clerk stated he understood that Mr. Willet, the owner of the Camden Park Estate, was interested in the company, whose action was taken in consequence of the development of the estate. Mr. Willet proposed that there should be no gas used in the houses to be built on his land, but that each house should be supplied with electricity supplied from a central station. The serious part of the matter was that if the company obtained the provisional order, they would shut out the authority from supplying electricity. The authority, however, could pursue the same plan as had been followed by the Bromley Local Board, who took out the order themselves. Mr. Clarence Smith said that what they had to do was to prevent the company from getting an order and not carrying it out. If this was a respectable company with plenty of capital, there was no need to oppose the application so long as the promoters were willing to supply the neighbouring property. The clerk said cases had been known in which companies without capital or reserves had obtained such rights of very large districts merely for the purpose of retailing them to others. On the motion of Mr. Clarence Smith, seconded by Mr. Charrington, it was resolved to make enquiries into the status of the applicants.

Hanley.—At the meeting of the Hanley Town Council last week the General Purposes Committee recommended that, in consideration of his extra services rendered in connection with the erection of the Victoria Hall and Quarter Sessions Court and the alterations to the Town Hall, the borough surveyor (Mr. J. Lobley) be allowed two months' leave of absence, and that he be granted the sum of £100. In moving that the recommendation be confirmed, Alderman Bromley said that Mr. Lobley had undertaken a great deal of work for the Corporation outside the strict duties of his office, and had thus saved the town a considerable sum in extras and architects' fees. He had well earned the gratuity of £100 which it was proposed to give him. Mr. Shirley seconded the motion, mentioning that Mr. Lobley proposed visiting America during his holiday, mainly with the object of enquiring into the question of lighting towns in that country by electricity. Alderman Charlesworth, in supporting the motion, said the borough was to be congratulated upon having in Mr. Lobley not only an efficient borough engineer, but a man of architectural skill. His extra services as an architect, not only in connection with the Town Hall, Victoria Hall, and Sessions Court, but at the Shambles and other Corporation property, had saved the town, it was estimated, at least £500 or £600. An amendment to the effect that the leave of absence be granted, but not the gratuity, having been proposed, the Mayor pointed out that the Corporation were committed to the expenditure within the next few years of £30,000 or £40,000 in electric lighting, and upon that question they required the fullest information. In America electricity for public lighting was more largely used than in this country, and as the surveyor was going to enquire into the subject during his holiday, he thought the Council would get their money's worth back again in the information and assistance he would be able to afford them. After a long discussion, the amendment was rejected, and the recommendation of the committee was then confirmed.

Withdrawal of the Birmingham Tramways Order.—The Central Tramways Company have, it is understood, abandoned the provisional order they were promoting in Parliament to authorise the extension of the electric tram line in Birmingham. This action has been forced upon the company by the opposition of the telephone company, which obtained from the Lords' Committee a clause requiring the tramway company to protect the underground telephones by making provision for return currents wherever electric tramway cables may be laid. The cost of such an arrangement, according to the tramway company's witnesses, would amount to £1,500 per mile, and the total cost, supposing electricity to be adopted throughout the tramway system, is estimated at £20,000. The directors felt that they could not ask their shareholders to submit to a requirement, in their judgment, so excessive and unjust, and therefore, rather than accept the clause, they have withdrawn their order. The immediate effect of the telephone company's opposition is that the Bristol-road electric trams must still stop in Suffolk-street to the great inconvenience of passengers, although the Navigation-street lines are laid and were used for a time, until it was found necessary to obtain further powers to legalise their use. The further and more serious effect is that the development of the electric system of traction is rendered impossible, because the cost of laying underground wires (the only method that will pay) is rendered too heavy through the demand of the telephone company. The application of the tramway company, it will be remembered, was strongly supported by the Corporation, and they resisted the claim of the telephone company. The success of the latter company, and the consequent necessary withdrawal of the tramway company's order, compels Birmingham to submit for an indefinite period to the nuisance of steam trams, which would otherwise have been replaced by electric trams. This result is greatly to be regretted. It is hoped that on a future application, made before another Parliamentary Committee, the tramway company may be successful in obtaining its order without the intrusion of the obnoxious clause.

Bradford Central Station.—Before the Bradford Town Council, on Tuesday, Alderman F. Priestman stated with regard to the electric lighting works, the present works had cost £35,000, and he was going to ask for £5,000 or £6,000 for increasing those works. It was proposed to put down one 300-h.p. engine, and two 80-h.p. engines. The works now were able to supply 3,500 amperes, and with this addition would produce 1,800 more. The proposal to light the Town Hall was before the Council, and would probably soon be carried out, and the committee had a large number of demands for the electric light current. They had not pressed the matter, for they had the interests of the gas works—in which a large amount of capital had been sunk—to preserve, but the increased demand was consequent upon the superiority of the electric light. He apprehended that the Council would wish that the committee should keep pace with these demands. The two smaller engines were required to obviate the necessity of running the larger engine in the morning, when the demand was at its minimum. By this means the very uneconomical proceeding of running a large engine at a low power was rendered unnecessary. Mr. Galloway objected to additional expenditure until the station paid. Mr. Alderman Feather objected to the expense of maintenance. He understood that they were at present consuming 6lb. of coal per hour for each indicated horse-power, which he had been informed could be reduced to 1½lb. per hour. He was further given to understand that a proposal had been made to the Halifax Corporation to supply a complete electric plant and guarantee a net profit of 7½ per cent. ; and if that could be done at Halifax, it could be done at Bradford. Alderman Priestman, in reply to Mr. Galloway, said he considered the proposed expenditure on the electric light station a wise expenditure. Up to the 31st of December, 1889, the loss on the electric lighting works was £1,079 ; during the half-year ended the 30th of June, 1890, the loss was £732 ; and from that date to the 30th of December, 1890, the loss was £315. That showed clearly that they were now on the verge of making the works pay, and from the facts and figures he had given to the Council he had not the slightest hesitation in saying that by the end of next year those works would be paying more than the interest on the money expended on them. Alderman Feather's statement as to the consumption of coal was not correct. The quantity of coal consumed depended on the quality of the coal used, and instead of the consumption reaching 6lb. per hour, it was more nearly about 2½lb. to 2¾lb. per hour. At certain periods, when only a very slight load was upon the engines, the consumption might be 6lb. per hour per horse-power, and that was the reason why he was asking for two small engines. He appealed to the Council to complete the installation in the way proposed by the committee. He believed that it would very soon be the duty of someone to ask the Council to spend an additional sum of money on the electric light works, and that would be the best time to deal with the question of economy of fuel. He thought the committee was proceeding in the most economical course possible. There had been a complaint in some quarters about the committee not adopting the alternating current, and in answer to that complaint he wished to state that the direct and continuous current was the one most favoured by authorities on the subject, and was the one which would probably be generally adopted in the future. The resolution was carried.

UNDERGROUND MAINS.—VII.

THE SILVERTOWN SYSTEM.

The chief feature in the system of underground mains advocated by the India Rubber, Gutta Percha, and Telegraph Works, Limited, Silvertown, E., usually known as the Silvertown Company, is the insulated conductor itself, the exact material of the pipe or conduit in which it is laid being in their opinion of secondary importance, so long as it permits of the employment of a drawing in and out system, and is sufficiently strong to afford adequate mechanical protection to the cable placed in it. The experience of the Silvertown Company as cable manufacturers extends over a considerable number of years, and during this time they have paid a great amount of attention to the perfecting of the design and manufacture of electric light cables, with a view to increasing their efficiency and durability, and have made many experiments not only with indiarubber, but also with waxes and bituminous and resinous compounds, used either alone or in conjunction with fibrous material and lead casings. In addition to this, they have had the opportunity of practically testing other systems of insulation which have been brought before them, and the result of this experience has been in their case to impress them with the opinion that for a thoroughly reliable and durable system the cable itself must be insulated as though it were to be used under water, and must at the same time be capable of standing considerable variation of temperature and exposure to the atmosphere, and that it must not depend in any way on the pipe or conduit as a protection, except against mechanical injury. The material which has been found most suitable for fulfilling these conditions is vulcanised indiarubber; and notwithstanding the expense in the first place, it is stated that owing to the saving in maintenance, the total cost of a system of rubber cables during a number of years will compare favourably with that of any other system—*i.e.*, that if the annual cost of maintenance is capitalised and added to the first cost in each case, the vulcanised rubber cable will more than hold its own.

For underground work two classes of cable are made: one suitable for high pressures, such as 2,000 volts, and another for medium and low pressures, say, up to about 600 volts. Both classes of cable consist of stranded tinned copper wire, insulated with first pure rubber, and then vulcanising rubber of the best quality, great care being taken in the selection and preparing of the rubber, and in the applying it to the conductor. The core thus made is vulcanised, and protected by compounded tapes and braiding, which have been found to provide ample protection against damage from handling and drawing into pipes when ordinary care is taken.

Before proceeding to the description of the method of laying these cables, we may mention that the Silvertown Company lay very great stress on the testing of every length of cable before it leaves their factory, and have adopted the plan of sending out a copy of the test with practically all deliveries of cable. The tests are all made in water, with a testing E.M.F. of about 500 volts, and the insulation resistance given is that at 60deg. F., after one minute's electrification. In addition to this quantatitive test, they are now prepared to subject all cables required for high-pressure circuits to a breaking-down test, at the same or a higher voltage than that at which the cables are to be used.

With regard to the system of laying the cables, the Silvertown Company are decidedly in favour of a drawing in and out system, and never, we understand, use any other, although, of course, their cables are sometimes laid otherwise when the laying is not under their control. Their reasons for this may be briefly stated as follows: The drawing-in system allows of extensions being easily made without disturbing the surface of the ground, as a small cable can be drawn out and replaced by one with a heavier conductor, and extra cables can be drawn in as required, if the precaution has been taken at the first opening up of the ground of laying spare pipes—which can be done at a very moderate cost compared with that of opening up the ground each time, or that of laying cables with the full section of copper when there is no prospect of their being required for immediate use.

This system also lends itself to the localisation of a fault, should one exist, and to its repair, owing to the ease with which a faulty length of cable can be replaced by a good length. Although not tied to any one particular form of conduit, they consider that a conduit made of cast-iron socket pipes is the best, since it combines great durability with economy of space, and affords an excellent mechanical protection. No special attempt is made to keep the conduit watertight, but the pipes are laid with a dip towards the surface-boxes, the bottoms of which (if there are any) are perforated, and the boxes themselves set on rubble, or other loose material, to facilitate the drawing off of water, which, if allowed to become stagnant, might cause unpleasant smells.

The joints between the conduit pipes are made with rubber rings of circular section, like enlarged umbrella rings, and this method of making the joints has been found very satisfactory, being more expeditious than lead joints, and making a flexible line of piping, which is less likely to receive injury from any external pressure than a rigid line. Surface boxes of brick or cast iron, generally the latter, are placed at every sharp bend in the line of pipes, and also in straight runs at about every 100 yards, more or less, according to the size and weight of the cables.

The cast-iron boxes (Fig. 1) are provided with an outlet on each of the four sides shaped like the faucet of the pipes, and these, if not required for pipe connections, are closed by a plug, and with a lid consisting of a cast-iron frame which can be filled in with material similar to the surrounding paving. Brick surface boxes (Fig. 2) are used where there are a large number of pipes, and where the box for any reason has to be of extra large size. For house services, smaller cast-iron boxes similar to those described above are used, or a length of pipe is replaced by a split T-piece of an enlarged sectional area (Fig. 3). As these pipes are laid, a wire is threaded through them and left in with its ends made fast in the surface boxes, ready to act as a hauling line when cables are to be drawn in. The cables are brought to the ground on drums, which are placed on stands near the surface boxes, so that they are free to revolve; the cable or cables are attached by a strong but smooth fastening to a rope, and this rope is pulled through the pipes by means of the hauling wire, and is itself used to guide the cable through. In straight runs the length of cable that can be pulled through at one time depends on its weight, but it is not often that this limit is reached, owing to the frequent changes of direction of the pipes, but when it is, and also at all sharp bends, the cable is brought up to the surface and coiled on the ground, the cable thus coiled being afterwards pulled through the next length of pipes in a similar manner. Soft soap or whiting is used as a lubricant to reduce the friction between the cable and the pipe, and if care has been taken during the laying to see that the way is clear, and no obstruction is left in the pipes, the cable can easily be pulled in without damage. With moderate-sized cables, such as are used on high-pressure circuits, two are drawn in together into each pipe, but with the heavier cables used on low-pressure systems, it has been found advisable to provide a separate way for each where objections do not arise, as they may in the case of alternating currents. On high-pressure circuits a continuous insulation is imperative throughout all the underground system, and the Silvertown Company therefore consider it advisable to vulcanise the rubber insulation of

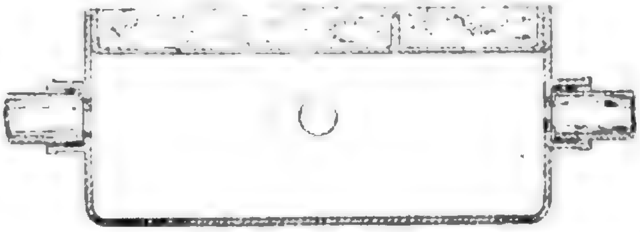

FIG. 1.—Drawing In and Joint Box. Silvertown System.

all joints underground, and with a view to facilitate this operation, they have devised a portable vulcanising kit, and drawn up a set of instructions for the proper making of these joints.

Although too long to give in full, a brief *résumé* of these instructions may be of interest, together with a description of the special "cure" employed. This latter consists of a cast-iron T-shaped box made in halves, with flanges so that they can be bolted together. Three circular openings are provided, one at each end of the box, and one at the end of the T-piece, for the introduction of the cables to be jointed, and an opening is provided in the top half for pouring in molten sulphur, and a cock on the bottom half for drawing it off at the end of the cure. The joint between the two halves of the box is made with asbestos packing, and those at the places where the cables enter, by wrapping the cable with a strip of common rubber. The sulphur is melted in a separate pot, and when all is ready is poured into the cure, the temperature being maintained by placing one or more spirit lamps under the cure, and observed by a thermometer introduced into the sulphur through the hole in the top of the box. With regard to the actual making of the joint, the following method is recommended: The copper joint is carefully soldered with resin as a flux and finished smooth and clean. The ends of the rubber, which have been exposed during the making of the copper joint, are then pared down to as long a taper as can be made, and the conductor is lapped tightly with one or more layers of pure rubber strip, which extend partly over the tapered surface of the original insulation. One or more layers of vulcanising rubber are then put on over the full length of the joint, care being taken to lap them so as to exclude air. The joint then made is tightly bound up with prepared tape, is then covered with a piece of sheeting, making a longitudinal seam, and firmly bound over all with selvedge tape. The sheeting and selvedge tape act as a mould to keep the joint in shape during the vulcanising process, and are removed again when this is completed. The two halves of the cure are then placed around the joint and are bolted together, the joints being made tight in the manner described above. Molten sulphur is poured in, and is maintained at a temperature of about 290deg. to 300deg. F. for half an hour, by which time the cure is complete; the sulphur is then drawn off, the cover removed, and the wrappings taken off the joint. If the rubber is properly cured, it should, when cold, be springy and yield to the pressure of the thumbnail, but no mark should be left when the pressure is removed. The joint is then finished by covering it with prepared tape as a mechanical protection.

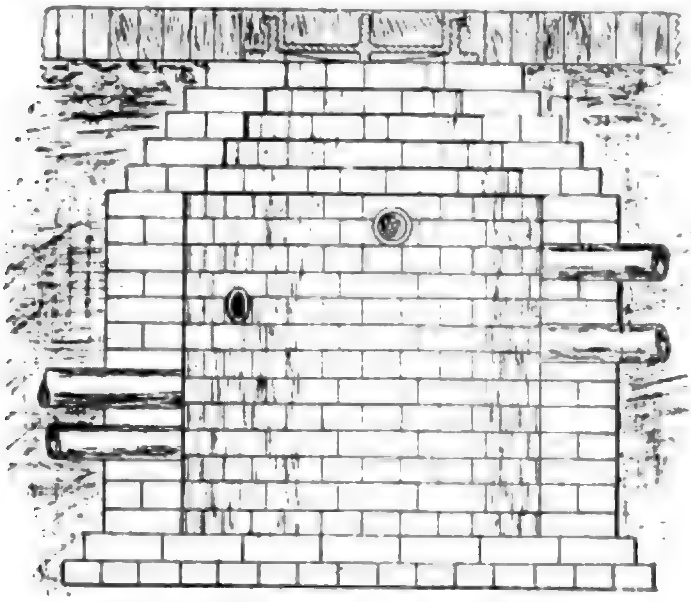

FIG. 2.—Brick Manhole. Silvertown System.

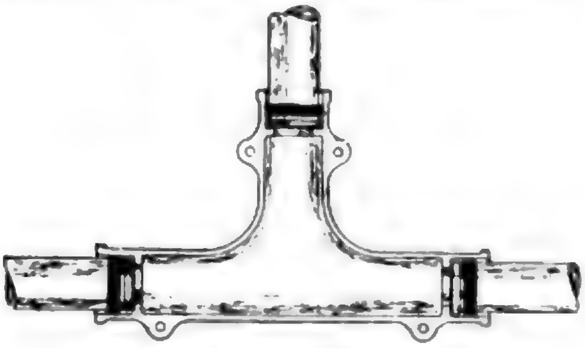

FIG. 3.—Branch Junction. Silvertown System.

The importance of good jointing is a matter which the Silvertown Company specially insists on, and it certainly seems rational that when a continuously insulated cable is employed no uninsulated conductor surface should be allowed underground. A system of separate short lengths of insulated cables into each house, such as adopted by Mr. Bailey for the Metropolitan Company, offers, however, very great advantages in the matter of testing, and facilitates the withdrawing and replacing of cables, and we understand that the Silvertown Company fully appreciates the advantage of such a system, where the connections can be made at the primary fuse-boxes in the householder's cellar, and where proper precautions are taken to prevent excessive surface leakages.

The Silvertown Company claims that it has an excellent record for underground work, as wherever their cables have been used and laid in accordance with their recommendations, the result has been eminently satisfactory. The amount of work done by them may be judged by the list we give below of the supply companies in Great Britain who are employing their cables, in addition to which they have also laid them for a large number of private installations, amongst them the lighting of their own factory, where rubber cables have been in use in concrete trenches for about eight years. On the Continent also the high-tension distribution in Paris, Tours, Madrid, and Barcelona is almost exclusively carried out with their cables, made either at Silvertown or Persan, and large quantities have been shipped to India, Australia, and South America for local supply companies:

London Electric Supply Corporation; Westminster Electric Supply Company; Metropolitan Electric Supply Company; House-to-House Electric Supply Company, West Brompton; Brighton and Hove Electric Supply Company; Crompton and Co., Chelmsford; Eastbourne Electric Supply Company; Muir, Mavor, and Coulson, Glasgow; Hastings and St. Leonards Electric Company; Newcastle-on-Tyne and District Electric Light Company; and Woking Electric Light Company.

CREOSOTING TIMBER.*

BY E. J. SILCOCK, A.M.I.C.E., F.G.S., BOROUGH ENGINEER, KING'S LYNN.

In bringing the subject of creosoting timber before this association it is hardly hoped that any new matter will be introduced. The whole subject has been most fully discussed by Mr. S. B. Boulton, A.I.C.E., in his paper on "The Antiseptic Treatment of Timber," read before the Institution of Civil Engineers, and the author acknowledges the great assistance which that paper has been in the preparation of the present communication. Although the subject has been so fully dealt with, the author finds no generally accepted practice, and having had some little experience of the work, hopes by means of this paper and a fresh discussion to ensure a greater uniformity in the specifications issued by the members of the association. There is at present such a variety in the requirements of different specifications that it is practically impossible to comply with all with the same plant. The result of this no doubt very largely is, that when firms are putting down creosoting plant they only provide for the requirements of the majority of their customers. Now, unfortunately, this majority is usually that section which is somewhat lax, and contractors take alike all orders with the hope that they may be able to get their work passed even in cases where their plant cannot carry out the specification. At present a good specification and thorough inspection are met with the declaration that there is no available plant in the immediate neighbourhood, and that we must therefore be satisfied either with getting what we can or send to a distance. Now, independently of the extra expense, this alternative renders thorough inspection extremely difficult, and is generally opposed by contractors or our clients. We all know there can be practically very little difference in the labour or time required to do the work efficiently or the reverse, and it is therefore evident that if there were a more uniform system of specifying, combined with more rigid inspection, the supply would soon meet the demand, for creosoting firms would speedily put down suitable plant for the work. No difficulty would then be experienced in getting what we require. The importance of having timber creosoted when it is to be subjected to the influences of the weather hardly admits of argument. Abundant evidence can be produced to show that where efficiently done the process at least doubles the life of timber. One or two facts on this head will suffice. The average life of an ordinary uncreosoted telegraph pole is, on the authority of Mr. W. H. Preece, F.R.S., chief electrician to the Post Office, about seven years, whereas a line of creosoted poles about 20 miles in length put down in 1848, were taken up in 1883, and were then perfectly sound. Again, on the Great Western Railway it is found that the life of uncreosoted sleepers is five years, and that of creosoted sleepers eight to ten years, and many last to double that length of time. In tropical regions timber is very rapidly destroyed by marine insects, more particularly the Teredo Navalis and Limnoria. On the Pacific and Atlantic shores of the States it is found that uncreosoted piles are destroyed in two years, whereas creosoted piles last from five to six years. Since then the process doubles the life of timber, and the cost of treatment is not more than 25 per cent. of the prime cost of the material, it is a self-evident proposition that all exposed timber should, where possible, be creosoted. If we add the cost of carpentry, driving and fixing the material to the prime cost, the case for creosoting is even stronger, in most cases not adding more than 10 per cent. to the cost of complete work. Many works carried out by members of this association involve the use of large quantities of timber, so that the importance of the subject in this regard should not be overlooked.

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* Paper read before the London meeting of the Association of Municipal and County Engineers.

Without going very deeply into chemistry, it may be stated that what is commonly called creosote is that portion of the products of the destructive distillation of coal tar which is heavier than water. When coal tar is distilled three groups of products are produced—viz.: (A) crude naphthas or oils lighter than water; (B) dead oil or creosote heavier than water, and (C) pitch. These oils contain many constituents, between which there is no clear dividing line, but the constituents of creosote may be divided into three groups: (1) the phenols or most volatile portions, the chief of which is carbolic acid; (2) the group the principal of which is naphthalene; (3) the least volatile or bituminous portions which distil over at a temperature beyond 535deg. F., the principal of which is anthracene. Decay of timber is brought about chiefly by three agencies—viz., by the fermenting of the albumenoids of the sap, by the admission of water into the cells of the wood, and by the attacks of insects. In all three directions creosoting acts as a preservative. The carbolic and other acids in the creosote coagulate the albumen of the sap and arrest the process of fermentation; the heavier portions of the creosote enter and fill up the pores of the wood, and so prevent the entrance of moisture; and the powerful smell of the creosote, and probably its flavour, deter insect life from penetrating the wood and taking up its abode in its cells. The modern germ theory has entirely revolutionised the accepted ideas of scientists on the subject of the putrefaction of animal and vegetable tissues. It was formerly believed that the coagulation of the albumenoids in these organic tissues permanently prevented putrefaction. It has, however, been demonstrated that the coagulation of albumenoids is not permanent, and that antiseptics (germ killers), which (like carbolic acid) are themselves soluble in water and volatile in air, are removed from their albuminates by the action of water and air, and so permit germ life or fermentation to set up. M. Pasteur has now clearly demonstrated that germs are the agents of decomposition, and that in their absence organic decomposition does not take place. Various kinds of fermentations, such as yeast, vinegar, beer, etc., have been traced by him to a specific germ, which can be detected and cultivated and relied upon to produce its special kind of fermentation. In attempting, therefore, to preserve timber, we must select such substances as will be capable of killing these organisms known as germs, and will produce such conditions as to prevent their development. Carbolic acid (a phenol), though a very powerful germ killer or antiseptic, is unfortunately very volatile in air and soluble in water, and several investigators have proved by analysis that it is present only in extremely small quantities in timber 12 months after treatment by creosoting. It would therefore appear that the extreme value of this acid, which was formerly so much insisted on, is somewhat doubtful. Still, there can be no doubt that the coagulation of the albumen which is effected at the commencement of the process is of value, especially as air and water are afterwards prevented from reaching the interior of the wood by the more bituminous portions of the creosote oils. The naphthalene group forms a large proportion, about 60 per cent., of the constituents of creosote oil, and has antiseptic powers, though they are less energetic in their immediate action than carbolic acid. Naphthalene itself is, however, practically insoluble in water, and is very much less volatile in air than the phenols, and at ordinary temperatures it solidifies and tends to prevent the escape of the more volatile portions of the oils, and the entrance of moisture and micro-organisms. Dr. Tidy made experiments with a view to determining the extent of volatilisation of naphthalene, and he was led to the conclusion that the loss was very rapid for a day or two, but after that period it decreased to almost nothing. This result has, however, not been verified by Dr. Clark, who recently read a paper on the permanency of creosoting agents. He found that volatilsation went on to a large extent for a very considerable period. This view accords with actual experience, for it is a very common thing to see the soil round sleepers discoloured by creosote 12 months after they are laid. Naphthalene must not therefore be looked upon as an absolutely stable body. Experiments are now being made in America with naphthalene alone as a preservative, but so far as the author knows no results have yet been published. There is, however, a practical difficulty in use of pure naphthalene, as its melting point is about 173deg. F., and therefore it must be raised to a very considerable temperature before injection.

Turning now to the heavier or more bituminous portions of the creosote—viz., those which distil over at a temperature beyond 535deg. F.—we find that their function is almost entirely confined to forming an impervious skin or shell round the timber, and to this Dr. Tidy attaches special importance, for in his specification he stipulates that not less than 25 per cent. of the oil should distil beyond 600deg. F. Creosote oils are divided into two classes, known as London or heavy oils, and country or light oils. The London oils are those obtained from coal tar made from Newcastle coal, whereas the country oils are made from coal from the Midland coalfields. The London tars yield less tar acid or phenols than the country tars, but they contain more naphthalene. In ordinary commercial creosote the phenols vary from 3 per cent. to 18 to 20 per cent. In considering the constituents for which it is necessary to specify in creosote, we find that formerly as much as 12 per cent. of phenols was sometimes specified. It appears, however, that a very much smaller proportion of phenols will effect the coagulation of the albumenoids which is at first required, and that if a greater quantity is provided it very quickly volatilises. It should be noted that the quantity of tar acids should bear some relation to the quantity of sap in the timber, so that for telegraph poles, hop poles, and similar young or sappy wood, the tar acids should be greater than for deals and whole timbers. Generally, however, it appears now to be the opinion that if 5 per cent. of tar acids are present, it will be sufficient for ordinary cases. The percentage of the heavier or pitchy constituents of the oil is also important. It is this portion which blocks up the pores of the timber. Dr. Tidy, as previously stated, specifies 25 per cent. of these constituents which do not distil under 600deg. F. This, the author submits, is impracticable, as from several analyses of commercial creosote he finds that the residue at 600deg. varies from 8 to 15 per cent. Probably 25 per cent. over 535deg. F. is about as much as is obtained in practice. At the same time the oil should be completely liquid at a temperature of 100deg. F., or it cannot be injected sufficiently freely into the fibre to form the skin or shell before referred to. No ammoniacal water should be present in the creosote, as it has an injurious effect upon the timber. It is the practice of some firms to mix crude tar with their creosote oils, especially if they use country oils. This course should be deprecated, as the crude tar contains all the oils lighter than water, which are of no value for creosoting purposes, and also a large quantity of pitch, the carbon in which prevents the oil from penetrating the fibres of the timber. Occasionally bone oils and mineral oils are used for creosoting purposes, but as they contain no antiseptics they are unfit for the purpose, and should be rejected.

In America creosote proper—*i.e.*, oils obtained from the distillation of wood—are largely employed. This, no doubt, arises from the fact that timber is much cheaper in America than in this country, whereas coal is much more expensive. Wood creosote is much more uniform in its constituents than coal-tar creosote, and is less volatile and soluble when exposed to air and water; it also contains no ammonia, which is considered to hasten decay. It is said to be much more effective in protecting timber from marine insects than coal-tar creosote. The quantity of oil to be injected varies in most specifications from 6lb. per cubic foot to 12lb. per cubic foot. Generally, it may be said that the more creosote is injected, the more efficient the process; but, of course, when this principle is carried to excess the expense becomes prohibitive, and it is found that, except in the case of very young timber or very small scantlings, 12lb. per cubic foot is about the practical limit. The author has, however, seen Baltic sleepers, 10in. by 5in., which absorbed over 20lb. per cubic foot, so that although for large scantlings it may not be possible to inject such a large quantity as this, still there is no practical difficulty in getting 10lb. to 12lb. injected into any timber of the coniferous class. The specific gravity of creosote being about 1·05, a gallon weighs 10½lb., and the author submits as a standard that one gallon per cubic foot should be required, as it is more convenient to measure the quantity in gallons than in pounds. The processes by which creosote is injected into timber in this country are four in number—viz., the open tank process, Bethell's process, Boulton's process, and Blythe's process. These will now be described in the order named. Of the open tank process very little need be said; it consists merely of steeping the timber in creosote in an open tank. Unless the process is carried on for a very lengthened period, say, several weeks, and the oil is kept at a high temperature, it does not penetrate beyond a very short distance from the surface of the timber, unless there is a large proportion of sap wood, or the scantlings are very thin. A few shavings with a plane will entirely remove all traces of creosote from the heart wood. This process, therefore, cannot be said to be very satisfactory.

In Bethell's process the timber is placed in closed iron cylinders, varying in length from 40ft. to 80ft., and in diameter from 4ft. to 7ft. The cylinders have hemispherical ends, one of which is loose and is suspended from an iron arm fixed to the cylinder, so that during charging and discharging it can be swung on one side. The cylinder is provided with a faced flange at the end which opens, and the hemispherical end is secured in its place by screw-clamps which clamp the end to the cylinder flange. The creosote is contained in a tank or tanks underneath, or to one side of the cylinder, and the tank and cylinder are connected by an iron pipe led from the bottom of the cylinder, and provided with a stop valve. Hot-water or steam pipes are taken from a suitable boiler and furnace into the creosote tanks, so that the temperature of the oil can be raised to 150deg. F. before admission to the cylinder. An air pump and a pressure pump, driven either by steam or hydraulic power, are placed in a shed adjoining the cylinder; the air pump being connected to the creosote cylinder by suitable piping, and the pressure pump drawing its supply of creosote from a tank and discharging it into the creosote cylinder. It is preferable, if possible, to have a separate tank for the pressure pump to draw from, as the quantity of creosote injected can then be more accurately measured. The process is then carried out as follows: The timber is placed in the cylinder, the hemispherical end fixed, and the air pump is set to work to exhaust the air from the space unoccupied by the timber and from the pores of the timber, the valve between the cylinder and the creosote tank being closed and a vacuum of about 10lb. per inch being maintained. At the end of an hour the valve is opened, and the atmospheric pressure causes the creosote to rise up the pipe connecting the cylinder and tank, and fills up all spaces in the cylinder not occupied by timber. When the tank is full the air pump is stopped and the pressure pump is set to work, and creosote is pumped in under pressure until the required quantity has been injected into the wood. The time occupied in this operation depends on the quantity to be injected and the state of the timber, varying from 10 minutes to as many hours, the pressure varying from 30lb. per square inch up to 120lb. per square inch. The quantity to be pumped is determined by multiplying the cubical contents in feet of the charge of timber by the specified quantity of creosote per cubic foot. The tank from which the pressure pump draws its supply is provided with a gauge by means of which the quantity pumped can be measured. When the required quantity of creosote has been injected the pump is stopped, and the valve connecting the cylinder with the creosote tank is opened, and the oil is allowed to drain back into the tank. The cylinder is then opened and the charge of timber withdrawn.

Boulton's process differs from Bethell's in that the temperature to which the oils are raised in the creosote cylinder is 212deg. F. to 220deg. F., instead of 120deg. F. To effect this, steam-pipes are introduced into the creosote cylinder. The plant required is similar to that for Bethell's process, except that besides the above-mentioned steam-pipes, a steam-dome is fitted to the cylinder, and a surface condenser to the air pump. The principle on which the process rests is the fact that whereas the boiling points of the creosote oils vary from about 250deg. F., to 700deg. F., that of water is 212deg. F., consequently all the moisture present in the timber is driven out in the form of steam by the heat of the oils, and this steam is exhausted by the air pump and subsequently condensed without any appreciable quantity of creosote being evaporated. At the same time the timber does not suffer from this excessive heat, because that heat is applied through the medium of the oils, and is not a dry heat. The process is carried out in the following manner: As soon as the cylinder is charged with timber and closed, oil is introduced until the cylinder is nearly full, and the temperature raised to 212deg. F. to 220deg. F. The air pump is then started, and the air and steam exhausted until no further water flows from the condenser. The pressure pump is then worked until the required quantity of creosote is injected. The timber absorbs a large quantity of oils by displacement as the moisture is driven out, so that the pressure pumps have less work to perform, and less oil has to be forced in by that means—a clear advantage over Bethell's process. The total quantity of oils injected is the sum of the quantity absorbed by displacement and the quantity injected under pressure. The first of these quantities is ascertained by completely filling the creosote cylinder and dome with oil before the air pump is started, then reading the gauge in the creosote tank. A small quantity of oil is then run back from the cylinder into the tank, to secure a space at the top of the cylinder in which the air and steam can gather. When the exhausting process is finished, the cylinder and dome are again filled and the gauge again read. The difference between the two readings gives the quantity required—*i.e.*, already absorbed. The second of these quantities is the balance required to comply with the specification, and this is then pumped in by the pressure pump from a tank fitted with a contents gauge. Boulton's process is a very marked improvement on the older system, more especially when treating timber which has been water-seasoned, or which is very green. To put it in plain words, the timber is boiled in the creosote, and by that means all the water and most of the sap are removed, as well as the air from the cells of the timber, and the creosote oils take their place. The advantages of the process are not so marked when treating deals or other sawn timber, which is usually fairly well seasoned and tolerably dry, but it is common practice to take Memel timber and pitch pine out of seasoning ponds, and put straight into the creosote cylinders. In such a case Bethell's process cannot materially reduce the quantity of water in the time; merely exhausting the air and reducing the pressure on the outside of the timber will not extract any large quantity of moisture, and when the pressure pump is put to work and the creosote forced into the timber, the water is only driven more deeply in, and then sealed in by the bituminous portions of the oils. It will thus be seen that it may be quite possible, by using Bethell's process, to fix in the timber an element of danger to its durability.

(To be concluded.)

THE DARMSTADT CENTRAL STATION.

The Darmstadt municipal authorities, if they have not yet made their central electric light station pay, have at least done good service in publishing very full reports of their accounts since the commencement of the undertaking in 1888. The following analysis of the report is given in the *Revue Industrielle*, and as it gives very full details both of the first cost of installation and of the various items of receipt and expenditure for the time the station has been working, these details, although applying to continental practice, cannot fail to be of considerable interest to all electrical engineers.

Distribution.—The network of conductors extends over 23 streets and squares, having 20 junction-boxes. The network is fed by feeders leading direct from the station to the points of distribution. The mains used are of lead-covered cable, armoured with iron on the outside. The following are the different sections and lengths both of street mains and service mains:

STREET MAINS.

Lengths	973·0	metres of conductors of	25	mm^2 section.
„	4,012·0	„ „	35	„
„	5,697·5	„ „	50	„
„	6,668·8	„ „	70	„
„	5,932·6	„ „	95	„
„	3,405·0	„ „	120	„
„	962·2	„ „	150	„
„	2,449·2	„ „	185	„
„	2,244·7	„ „	310	„
„	190·0	„ „	400	„
„	913·4	„ „	500	„
„	370·7	„ „	625	„
	33,819·1 total length.			

SERVICE MAINS.

Lengths	272·4	metres of conductors of	6	mm^2 section.
„	1,168·8	„ „	10	„
„	1,072	„ „	16	„
„	354	„ „	25	„
„	265	„ „	35	„
„	66	„ „	50	„
	3,198·2 total length.			

Total of the whole length of mains, 37,017·3 metres.

The mains have been tested at several points without any diminution of the insulation being found.

Plant.—Of the engines, dynamos, boilers, and accumulators, the first, the report states, have worked well, but trouble has been experienced with the accumulators. The glass vessels frequently cracked, and have finally been replaced by wooden cases, and the whole battery removed from a chamber partitioned off from the engine-room to a separate room. Since this time (August, 1889) the accumulators have acted with entire satisfaction.

Meters.—Each installation is fitted with an Aron meter. On August 1, 1890, 113 meters were in use.

Customers.—For the year 1889-90, the number of customers, including the theatre, was 125, using 576 lamps of 10 c.p., 2,594 lamps of 16 c.p., 1,263 of 25 c.p., and 24 lamps of 35 c.p.; also 26 arc lamps of six amperes, and 24 arc lamps of 10 amperes, equal in total to 5,493 lamps of 16 c.p. There were, besides, two motors of 1¼ h.p. each.

(The theatre alone has 489 lamps of 16 c.p., 1,210 of 16 c.p., 787 of 25 c.p., and 18 arcs of 10 amperes.)

During 1890 this list received the addition of 15 customers, with 15 10-c.p. lamps, 291 16-c.p., 43 25-c.p., 6 35-c.p. lamps, and 4 arcs.

The receipts since the time of working—1st September, 1888, to 31st March, 1889—for sale of current were 43,234·55 marks (say, £2,161), consisting of:

Private lighting.................. 23,175·10 marks (£1,158).
Theatre of the Grand Duke ... 20,059·36 „ (£1,002).

Under these conditions, one incandescent lamp, reduced to an average of 16 c.p., has brought in for supply of current during eight months:

(*a*) For private lighting: 11·34 marks (the mark is practically 1s.), corresponding to a mean period of lighting of 283·5 hours per annum.

(*b*) For the theatre: 6·58 marks, corresponding to an average service of 164·5 hours per annum.

For the year 1889-90 the receipts showed 55,822·84 marks, comprising:

Private lighting.................. 32,884·08 marks.
Theatre lighting .... 22,938·76 marks.

A 16-c.p. lamp therefore brought in during 1890:

(*a*) Private lighting, 13·44 marks, corresponding to an average service of 336 hours per annum.

(*b*) Theatre lighting, 7·53 marks, corresponding to a service of 188·3 hours per annum.

Cost of Production.—The reports show that the consumption of fuel in 1888-89 was 3·02 kilogrammes (6·64lb.) per horse-power hour. In 1889·90 this became 2·46 kilogramme (5·41lb.).

The fuel exclusively used was coal from the Pluton mines. In 1888-89 the consumption was 509,005 kilogrammes (1,119,810lb., or 500 tons), which gave in clinkers and ashes, etc., 34,884 kilogrammes, or 6·85 per cent. In 1889-90 the consumption was 545,326 kilogrammes (531 tons), with a residue of 26,507 kilogrammes, or 4·86 per cent.

The consumption of water for boiler supply and cleaning according to the registration of the water meters, was 4,593 cubic metres; and in 1889-90, 3,917 cubic metres.

As regards the four engines, the number of hours worked was 3,295 in 1888-89, and the total output 841,973 ampere-hours, 168,584 horse-power hours. In 1889-90 the hours of working were 4,902, total output 1,108,801 ampere hours, or 221,770·2 horse-power hours.

The following are the figures of the work done by the accumulators in 1888-89, from November to March:

Charge.......................... 118,480 ampere-hours.
Discharge .... 73,677 ampere-hours.
Mean efficiency in ampere-hours, 62·1 per cent.

In 1889-90, from 1st April, 1889, to end of March, 1890

Charge.......................... 266,610 ampere-hours.
Discharge .... 154,198 ampere hours.
Mean efficiency in ampere-hours, 57·8 per cent.

The smallness of the use made of the battery is explicable, in the first place, to the alterations mentioned above, but, above all, for the reason that the large battery had to be reserved for the theatre in order to assure light, in case of need, from 6.30 to 10 p.m.—*i.e.*, just at the moment when it might be most advantageously employed. After the closing of the theatre the accumulators light the town, and are working at the maximum to 11.30—that is, for an hour at most—when they furnish all the current. After 11.30 p.m. the consumption is rapidly lowered, and remains stationary until 8.30 a.m. next morning. After this the battery is again used for about an hour to furnish a maximum current. As it is always in the morning that the rehearsals take place, for which the lighting is very variable, the battery must be at once charged to its full capacity, in order to furnish any lighting that may be necessary. With another arrangement the dynamos might have been run all the morning, which would be a good deal cheaper than the use of the batteries, and the battery need only be charged sufficiently for ordinary requirements.

Financial Statistics.—The following are the figures given in the report of the cost of construction :

Central Station.	Marks.
Steam engines	51,750·10
Dynamos	49,887·17
Accumulators	22,309·66
Movable cranes	2,706·42
Boilers	39,908·25
Instruments and apparatus	39,968·44
Total (marks)	206,530·04
Mains.	
Cost of conductors	199,920·63
Laying	10,912·46
Junction-boxes	6,440·93
Total (marks)	217,274·02
Buildings.	
Cost of sites	50,055·35
Generating station	62,026·94
Heating by steam	976·83
Front of building	40,470·93
Accessories	4,970·37
Total (marks)	158,500·42
Management and General Expenditure.	
Management of works	31,390·97
General expenditure	9,569·31
Total (marks)	40,960·28
Incidental Expenses.	
Cost of installations at customers	36,806·53
Telephone	84·71
Total (marks)	36,891·25
Summary.	
According to the figures above the cost of construction amount to	660,156·01
From this are reimbursements for installations carried out	43,522·24
Leaving (marks)	616,633·77

The customers have to pay the necessary charges for laying the current on to the house, for the running of all wires inside the entrance of the house, as well as all necessary fittings. For the meters, which are lent by the town, 5 per cent. of their value is to be paid as hire. The normal price of one 16 candle-power hour is four pfennig, equal to just under ½d. The charges for incandescent lamps of higher candle-power, and of arc lamps, are either reckoned proportionately to the consumption of current or the candle-power.

After the station had been put into operation it was decided, besides this, that the customer must pay for all arc carbons used as well as for the cost of these lamps themselves, while the incandescent lamps were to be supplied and renewed by the town. Against this the Municipality levied an annual tax of six marks per incandescent lamp of 10 c.p. to 50 c.p., and of 25 marks per arc lamp. These conditions were not approved by the customers, and were afterwards modified (1st September, 1889), enacting that the customers must procure not only the arc lamps and their carbons, but also the incandescent lamps, or rather buy them at the electric station, the tax for lamps being altogether suppressed. At the same time a minimum period of lighting was enacted, corresponding for a 16-c.p. lamp in private houses to 0·6 of an hour a day, and in shops and factories to one hour a day. The other incandescent lamps, and the arc lamps, have proportionate minimum periods. The subscriber who has not paid for the full minimum is charged the difference at the end of the year. On the other hand, the following rebates are given, taking the 16 c.p. as basis.

Hours of service.	Rebate.
800 hours a year per lamp	5 per cent.
1,000 " "	7½ "
1,200 " "	10 "
1,500 " "	12½ "
2,000 " "	15 "

From the table of the "active" and "passive" capital in the electric light station on April 1, 1890, as well as the statement of receipts and expenditure of the 16 candle-power hour taken as basis, it appears as if the Municipality would have to subscribe yet further to the cost of maintenance before the installation is on a paying basis.

Statement of Accounts, April 1, 1890.

1. ACTIVE.

	Marks.
Engines, boilers, dynamos, cranes, apparatus, and instruments	189,388
Accumulators	22,734
Installation material	5,208
Mains	243,753
Buildings	164,688·93
Provision of reserve material, installation stores, warming apparatus, etc.	11,379·86
Total (marks)	637,151·79

2. PASSIVE.

Capital : Loan July 1, 1888, at 3½ per cent., 627,500, less sum deducted for 1888-9, 3,137·50	624,362·50
Loan at 4 per cent. from Municipality, subvention for extraordinary expenditure	1,409·43
Funds for maintenance provisionally put at the disposal of the electric light fund	11,379·86
Total (marks)	637,151·79

Statement of Receipts and Expenditure, 1889-90, *including Accessories Revenue.*

1. RECEIPTS.	Marks.
Sale of current	55,822·84
Lamp tax	6,907·81
Hire of meters	837·53
Sale of arc lamps and carbons	539·74
Rent received for buildings and sites	900·00
Various receipts	226·26
Charge for house installations	2,513·56
Total receipts (marks)	67,747·74

2. EXPENDITURE.	Marks.
Interest on capital	21,907·50
Sinking sum on loans	3,137·50
Salaries and wages	17,284·09
Office expenses	929·27
Commissions	45·48
Taxes and contributions	1,005·15
Maintenance of buildings, etc.	337·90
Maintenance of machinery	839·15
Consumption of fuel and water	11,674·45
Cleaning material and oil	1,432·42
Lighting of station	1,509·11
Maintenance of underground mains	14·53
Manufacture and maintenance of meters	1,013·79
Manufacture of incandescent lamps	8,323·86
Manufacture of arc lamps, etc.	454·67
Maintenance of instruments and tools	162·37
Cost of house installations	2,130·12
Renewal funds	12,472·11
Total expenditure (marks)	84,073·47

The hour of service for one 16-c.p. incandescent lamp costs four pfennig, or ½d., so that for a sale of current of M. 55,822·84, the number of lamp-hours is 1,395,571.

It results, from above, that the cost price per 16 c.p. lamp-hour at the customer, deducting the accessory receipts, is :

$$\frac{84{,}073\cdot 47 \; - \; 11{,}924\cdot 90}{1{,}395{,}571} = 5\cdot 1069 \text{ pfennig, or about } 0\cdot 6\text{d.}$$

THE

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IMPORTANT NOTICE.

We may occasionally follow the lead of our American Contemporaries, especially when they point out a serviceable way. They are not backward in asking their friends to do all they can for the welfare of the paper. We ask our friends to remember us. No Paper that we know ever refuses Subscribers or Advertisers. Nor do we; in fact, we invite them, believing that they will get full value for their money.

Specimen copies of the paper will be sent on request.

CARLOW.

The recent election at Carlow has made prominent at the present moment a town which seems destined to become still more prominent, being the first Irish town to recognise and act upon the conclusion that the waste water power near a town might with advantage be utilised to provide light. The ordinary Englishman, used to the high pressure of business life, can hardly realise the exact position of such towns as Carlow in the ranks of progressive towns. To him, accustomed as he is to noise and bustle, the quietude of a prosperous, comfortable county town in the midst of a purely agricultural country is characteristic of Rip van Winkleism rather than of progress. But, on the other hand, those who live in remoter districts claim to recognise the go-aheadness of such places as Carlow. From whatever standpoint one views the situation, the fact remains that Carlow, for good or for ill, has taken a step which other places have talked about, and done, when the talk has ended, absolutely nothing. Situated some 56 miles south of Dublin, at the junction of the Burren with the Barrow, a considerable amount of water power is available. In years gone by, before Russia, America, and remoter parts of the earth supplied us with corn and flour, huge mills were actuated by the waters of the Barrow, and many another Irish stream. Now the mills are not worked. More modern milling appliances, added to the action of the Corn Laws, have driven the industry into other quarters. At Milford, some five miles from Carlow, stands one of these some time silent mills, its huge waterwheel inactive, and its gearing rusting away. The happy thought of using the waste power came to willing ears, and the result has been to install in a portion of the old mill, a dynamo-room, the machinery in which is at present driven by the old mill wheel, but which will soon be driven by turbines. With a little care we should imagine some three hundred horse-power can be obtained from the Barrow at this point, and two-thirds of that power would suffice to light every nook and corner of Carlow. The matter of the town lighting had long been a sore point. The Commissioners and the gas company did not quite agree, and latterly the town was lighted with oil—when the question was put to Mr. J. E. H. Gordon, who grasped the situation, made his proposal to the Commissioners, which was accepted, and within a few months of such agreement the work has been so far completed that the town lighting is regularly carried out. The formal inauguration of the lighting was, as is usual in such cases, made the pretext for a convivial meeting and dinner at the Town Hall on Monday last. Mr. Hammond, the newly-elected member of Parliament for Carlow, who has for 12 years been chairman of the Town Commissioners, delayed taking his seat in the House of Commons in order to be present at the inaugural banquet. This action tells its own tale as to the interest taken in the lighting. Deputations from Derry, Kilkenny, Portadown, and other places were also present to inspect the works and the results at Carlow, and from what we could gather it is pretty certain that a number of towns will follow the lead given to them. It seems to us, then, that a good meed of praise should be given to everyone connected with this lighting. Certainly Waterford, Belfast, and other places in Ireland have not been behindhand in introducing the light, but here we have an inland town of only some six thousands of population, with no factories, initiating the use of its natural sources of power to give light; and undoubtedly throughout the length and breadth of Ireland this attempt will be closely watched, and wherever water power is running to waste, sooner or later it will be utilised. It is not our intention to enter into details of the lighting here—that must be reserved for another issue—but we may say briefly the current is generated at 2,500 volts pressure, carried by overhead wires to the town five miles away, and transformed down to 50 volts. The transformed current will, when the work is finished, feed a network of low-pressure mains, from which the arc lamps lighting the streets and the incandescent lighting the interiors of the houses will be fed. It is but just to say the price of gas in Ireland, averaging six or seven shillings per 1,000 cubic feet, makes the introduction of the electric light less difficult than it might otherwise be. There is some probability of being able to compete in price, and the other advantages of electricity should bring it well to the front. There is one question which might be strongly insisted upon by those interested in the welfare and development of industrial Ireland. The example of Carlow must lead to the examination of the possibility of using this waste water power in various industries by the use of electric transmission and of motors. Coal is comparatively dear in many parts of Ireland, while water power is abundant. Surely some means may be devised of placing this hitherto waste power in the hands of users in the quantities they desire.

PROVISIONAL ORDERS.

According to the Board of Trade report just issued, 70 applications were made during the year for provisional orders. Of this number 37 were made by local authorities, and 33 by companies or individuals. Twelve of the orders relate to London. Out of the 70 applications, 59 orders have been secured. The Board of Trade seems to follow an almost hard-and-fast rule, granting without demur an order to the local authority, and refusing an order unless backed with the consent of the local authority. At any rate, only one order so opposed has been granted—in respect of a part of the parish of St. Luke, Chelsea, to the New Cadogan and Belgrave Company. Strictly speaking, however, this opposition was not to the company's application, but to clauses inserted at the instigation of the London County Council. The appendix to the report is somewhat interesting. The boom of the early eighties is still remembered, and the passing of the 1882 Bill led to a rush for orders in 1883. In that year 69 orders were granted, and of these all but 13 have been worked. Several of the 13 have really proceeded with the work—the most prominent being St. Pancras and Bradford—but others have made no movement, or so little as to be unworthy the name of work. No licenses have been applied for during the past year; the two referred to in the preceding report—viz., Chelmsford and Bath—were duly granted, and, as our readers know, both these towns are lighted. Besides these, a total of 11 licenses have been granted which have not in some way been repealed. Between 1883 and 1889 only two orders remain unrevoked, while during 1889-1890, out of 86 orders granted only two have been revoked, so that at the present time 156 orders are running, in addition to 13 licenses.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

TOWNLEY'S DUPLEX ALARM.

Sir,—Having seen in your issue of to-day's date a description of Townley's duplex alarm, I should be greatly obliged if you could allow me space in your columns to state that as far back as March, 1886, I designed, and have used ever since, a practically similar combination (mounted on a neat carved bracket) comprising alarm, clock, battery, and, of course, an ordinary form bell, with the improvement of mercury cups to receive clock legs, and also, by turning a small knob, in the event of a breakdown, the electrical clock contacts were thrown out of gear and the ordinary mechanical alarm substituted.

I merely wish to show that there is no novelty attached to Townley's alarm.—Yours, etc., A. McMerkin.

Norwood, S.E., July 10, 1891.

Sir,—We notice in your current number a description of a new form of electric trembling bell, said to have been invented by Mr. J. Townley. We do not know when this gentleman may have invented his bell, but we beg to inform you that our Mr. W. R. Wynne patented a bell on this principle in 1885 (patent No. 7,373), and that we have been manufacturing and supplying these bells for some time. Our patent bell has fewer working parts than the one illustrated by you, and, as we believe, is a far more practicable and reliable article.—Yours, etc.,

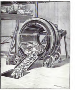
Barnett, Wynne, and Barnard.

Newcastle-on-Tyne, July 10, 1891.

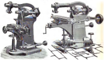
MAGNETIC BONE SEPARATOR.

Amongst the machines shown at the recent meeting of the Royal Agricultural Society at Doncaster, referred to in our notice of the show, and entered as a new implement, was the magnetic separator, which we now illustrate. This machine is intended to remove bolts, nuts, nails, horseshoes, etc., from bones, oil cake, or minerals, before they are passed into disintegrating machines, as the presence of these foreign bodies is very detrimental to the machines. The chief difficulties that had to be overcome in designing this machine were the large size and irregular shapes of the material to be treated; the fact also that the iron, particularly in bones, is frequently entangled in the bones, so that merely passing the substance once over or on to a magnet was not found sufficient to ensure the absolutely certain removal of the foreign substance. These points have been satisfactorily overcome by the use of a hollow truncated cone, with 10 internal magnets, of alternately opposite polarity. The cone revolves on outside runners, driven by friction only, which is found ample for the purpose.

Into the back end the bones are fed by a shoot, and, falling to the bottom, are rolled over and over again, so that, as they gradually travel forward in about 10 or 15 complete revolutions in the drum, they pass 100 to 120 times over the magnets. In the upper part of the barrel is a fixed tray into which the iron is carried and collected.



Magnetic Ore Separator.



Britannia Company's Milling Machines.

Each magnet in turn as it comes to the bottom is magnetised, and remains so till it reaches the top, where it becomes demagnetised, and the iron is detached. This process is carried out by a commutating ring on the back of the machine, and the arrangement is such that each coil has one end permanently connected to one pole of the dynamo, and the other ends are in turn connected during one half a revolution to the other pole. Thus the magnets receive current in parallel. Before cutting a coil out of circuit, it is short-circuited through a resistance, and by this means no sparking of any consequence occurs.

The machine has proved itself a very practical success, and the value of the repeated revolutions over the magnets have been demonstrated by repeated trials. The power required to excite the magnets is about 600 watts for the largest size, capable of dealing with four tons of bones per hour.

The machine was exhibited by the Hardy Patent Pick Company, of Sheffield, makers of the Devil disintegrator, and was manufactured by W. T. Goolden and Co., under the joint patent of Messrs. D. and C. Atkinson and G. W. Elliott.

MILLING MACHINES.

The Britannia Company, of Colchester, recently issued a book upon "Screw-cutting and Milling Machines," which very completely went into the theory and practice of screw cutting of all kinds. Many new types of milling machines were therein illustrated, and we give on opposite page two of the most modern and improved machines, which will not fail to be of interest to electrical engineers.

EXPERIMENTS WITH ALTERNATE CURRENTS OF VERY HIGH FREQUENCY AND THEIR APPLICATION TO METHODS OF ARTIFICIAL ILLUMINATION.*

BY NIKOLA TESLA.

There is no subject more captivating, more worthy of study, than nature. To understand this great mechanism, to discover the forces which are active, and the laws which govern them, is the highest aim of the intellect of man.

Nature has stored up in the universe infinite energy. The eternal recipient and transmitter of this infinite energy is the ether. The recognition of the existence of ether, and of the functions it performs, is one of the most important results of modern scientific research. The mere abandoning of the idea of action at a distance, the assumption of a medium prevading all space and connecting all gross matter, has freed the minds of thinkers of an ever present doubt, and by opening a new horizon—new and unforeseen possibilities—has given fresh interest to phenomena with which we are familiar of old. It has been a great step towards the understanding of the forces of nature and their multifold manifestations to our senses. It has been for the enlightened student of physics what the understanding of the mechanism of the firearm or of the steam engine was for the barbarian. Phenomena upon which we used to look as wonders baffling explanation we now see in a different light. The spark of an induction coil, the glow of an incandescent lamp, the manifestations of the mechanical forces of currents and magnets, are no longer beyond our grasp. Instead of the incomprehensible, as before, their observation suggests now in our minds a simple mechanism, and although as to its precise nature all is still conjecture, yet we know that the truth cannot be much longer hidden, and instinctively we feel that the understanding is dawning upon us. We still admire these beautiful phenomena, these strange forces, but we are helpless no longer; we can, in a certain measure, explain them, account for them, and we are hopeful of finally succeeding in unravelling the mystery which surrounds them.

In how far we can understand the world around us is the ultimate thought of every student of nature. The coarseness of our senses prevents us from recognising the ulterior construction of matter, and astronomy, this grandest and most positive of natural sciences, can only teach us something that happens, as it were, in our immediate neighbourhood; of the remoter portions of the boundless universe, with its numberless stars and suns, we know nothing. But far beyond the limit of perception of our senses the spirit still can guide us, and so we may hope that even these unknown worlds—infinitely small and great—may in a measure become known to us. Still, even if this knowledge should reach us, the searching mind will find a barrier, perhaps for ever unsurpassable, to the true recognition of that which seems to be, the mere appearance of which is the only and slender basis of all our philosophy.

Of all the forms of nature's immeasurable, all-pervading energy, which, ever and ever changing and moving, like a soul animates the inert universe, those of electricity and magnetism are perhaps the most fascinating. The effects of gravitation, of heat and light we observe daily, and soon we get accustomed to them, and soon they lose for us the character of the marvellous and wonderful; but electricity and magnetism, with their singular relationship, with their seemingly dual character, unique among the forces in nature, with their phenomena of attractions, repulsions and rotations, strange manifestations of mysterious agents, stimulate and excite the mind to thought and research. What is electricity? and What is magnetism? These questions have been asked again and again. The most able intellects have ceaselessly wrestled with the problem; still the question has not as yet been fully answered. But while we cannot even to-day state what these singular forces are, yet we have made good headway towards the solution of the problem. We are now confident that electric and magnetic phenomena are attributable to ether, and we are perhaps justified in saying that the effects of static electricity are effects of ether under strain, and those of dynamic electricity and electromagetism effects of ether in motion. But this still leaves the question, as to what electricity and magnetism are, unanswered.

First, we naturally enquire, What is electricity, and is there such a thing as electricity? In interpreting electric phenomena, we may speak of electricity or of an electric condition, state or effect. If we speak of electric effects, we must distinguish two such effects, opposite in character and neutralising each other, as observation shows that two such opposite effects exist. This is unavoidable, for in a medium of the properties of ether we cannot possibly exert a strain, or produce a displacement or motion of any kind, without causing in the surrounding medium an equivalent and opposite effect. But if we speak of electricity, meaning a thing, we must, I think, abandon the idea of two electricities, as the existence of two such things is highly improbable. For how can we imagine that there should be two things, equivalent in amount, alike in their properties, but of opposite character, both clinging to matter, both attracting and completely neutralising each other? Such an assumption, though suggested by many phenomena, though most convenient for explaining them, has little to commend it. If there is such a thing as electricity, there can be only one such thing, and, excess and want of that one thing, possibly; but more probably its connection determines the positive and negative character. The old theory of Franklin, though falling short in some respect, is, from a certain point of view, after all, the most plausible one. Still, in spite of this, the theory of the two electricities is generally accepted, as it apparently explains electric phenomena in a more satisfactory manner. But a theory which better explains the facts is not necessarily true. Ingenious minds will invent theories to suit observation, and almost every independent thinker has his own views on the subject.

It is not with the object of advancing an opinion, but with the desire of acquainting you better with some of the results, which I will describe, to show you the reasoning I have followed, the departures I have made—that I venture to express, in a few words, the views and convictions which have led me to these results.

I adhere to the idea that there is a thing which we have been in the habit of calling electricity. The question is, What is that thing? or, What, of all things, the existence of which we know, have we the best reason to call electricity? We know that it acts like an incompressible fluid; that there must be a constant quantity of it in nature; that it can be neither produced nor destroyed; and, what is more important, the electromagnetic theory of light and all facts observed teach us that electric and ether phenomena are identical. The idea at once suggests itself, therefore, that electricity might be called ether. In fact, this view has in a certain sense been advanced by Dr. Lodge. His interesting work has been read by everyone, and many have been convinced by his arguments. His great ability, and the interesting nature of the subject, keep the reader spellbound; but when the impressions fade, one realises that he has to deal only with ingenious explanations. I must confess that I cannot believe in two electricities, much less in a doubly constituted ether. The puzzling behaviour of the ether as a solid to waves of light and heat, and as a fluid to the motion of bodies through it, is certainly explained in the most natural and satisfactory manner by assuming it to be in motion, as Sir William Thomson has suggested; but, regardless of this, there is nothing which would enable us to conclude with certainty that, while a fluid is not capable of transmitting transverse vibrations of a few hundred or thousand per second, it might not be capable of transmitting such vibrations when they range into hundreds of million millions per second. Nor can anyone prove that there are transverse ether waves emitted from an alternate-current machine, giving a small number of alternations per second; to such slow disturbances, the ether, if at rest, may behave as a true fluid.

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* Lecture delivered before the American Institute of Electrical Engineers at Columbia College, New York, May 20.

Returning to the subject, and bearing in mind that the existence of two electricities is, to say the least, highly improbable, we must remember that we have no evidence of electricity, nor can we hope to get it, unless gross matter is present. Electricity, therefore, cannot be called ether in the broad sense of the term: but nothing would seem to stand in the way of calling electricity ether associated with matter, or bound ether; or, in other words, that the so-called static charge of the molecule is ether associated in some way with the molecule. Looking at it in that light, we would be justified in saying that electricity is concerned in all molecular actions.

Now, precisely what the ether surrounding the molecules is, wherein it differs from ether in general, can only be conjectured. It cannot differ in density, ether being incompressible; it must, therefore, be under some strain or in motion, and the latter is the most probable. To understand its functions, it would be necessary to have an exact idea of the physical construction of matter, of which, of course, we can only form a mental picture.

(To be continued.)

THE ELECTRIC TRANSMISSION OF POWER.*

BY GISBERT KAPP.

LECTURE I.—*(Concluded from page 42.)*

I need hardly say that, at the present time, no English millowner would dream of working his mill in this fashion by animal power, since coal is yet abundant, and a single steam engine is a far cheaper and handier instrument for producing and controlling a large amount of power than an equivalent number of horses. On the other hand, if power is required in small quantities, and in particular ways, then the horse will produce this power better, more cheaply, and more conveniently than the steam engine. It may seem absurd to work a large cotton mill by horse gear; but substitute for the mill a farm, and you see at once that the transmission of stored power to it, in the shape of corn, is a necessary part of the agricultural operations. Now the horses, in bringing the corn to the place where the power is required, perform work and must consume an equivalent amount of food. They also perform work in bringing the empty carts back again to the field to be recharged. The ratio between the amount of corn delivered at the mill and the amount taken out of the field would therefore represent the efficiency of transmission. If this is to be 90 per cent., as is the case of electric transmission, we may take it that, for every 100 sacks of corn taken away from the field, the horses would eat on the outward journey (when the carts are heavily laden) 6½ sacks, and on the homeward journey (when they are empty) 3½ sacks, leaving 90 sacks of corn to be converted into live power at the mill. The distance to which we can thus carry stored power with a standard efficiency of transmission is a measure of the merit of the system, as far as economy of power is concerned.

The transmission of stored power in the shape of fuel is a parallel case. We load the coal at the pit's mouth into waggons, and haul them by means of locomotive engines to the places where the power is wanted. Part of the coal is consumed on the outward and homeward journey of the train, leaving the rest for the production of live power at the mill. If this amounts to 90 tons out of every 100 tons put on the train at the pit's mouth, we have again an efficiency of transmission of 90 per cent.

I have already mentioned that the exact distance to which we can carry power by either of the three agents here mentioned—namely, batteries, corn, and coal—depends very much on the kind of road over which the transmission takes place. We might assume an almost infinite variety of cases, but, as our object is to obtain a rough general comparison of the different systems rather than exact figures for any one of them, I have assumed merely three kinds of roads—namely, a common carriage road, a tramway, and railway—and have calculated the distance to which power can be transmitted in each case with a loss of 10 per cent. The results of these calculations are given in the following table. The speed of transmission has been assumed at four, six, and 20 miles for road, tram, and rail respectively, when coal or batteries are the transmitting agents; and at four miles on all kinds of road when corn is the transmitting agent. In all cases I have assumed that the road is the best of its kind, perfectly free from gradients or curves, and that the traffic can be worked at the speeds mentioned without interruption. In reality, these conditions will, of course, not all be fulfilled; we have to make allowances for waste of power on gradients, curves, bad places in the road, for running at variable speed, and for stopping and starting. The distances given in the table are, therefore, throughout too large; but as our purpose is merely the comparison of the different systems, we may take the figures in the table as a rough indication of the merits of each. The figures show the distance in miles attainable with 90 per cent. efficiency of transmission over road, tram, and rail:

TRANSMISSION OF STORED POWER.

Source of power.	Road.	Tram.	Rail.
Coal and steam engine	115	270	1,300
Corn and horse	52	170	440
Storage battery and electromotor	4	10	28

You will see, from this table, that as regards efficiency the electric transmission of stored power cannot compete with the other two methods. A horse and cart carrying corn over an ordinary carriage road works with twice the efficiency of the electric locomotive taking batteries over a railway. The discrepancy is still greater if we compare the electric locomotive hauling batteries with the steam locomotive hauling coal. The latter can transmit power over a distance 50 times that over which the former can transmit power with an equal efficiency. On a tram line the distance over which we can transmit power with an efficiency of 90 per cent. is, according to the table, 10 miles—that is to say, if the whole load of the car is composed of batteries, we can run it 10 miles out and 10 miles home at an expenditure of 10 per cent. of the total charge of the batteries. Now let us see how this compares with the storage cars in use on passenger tram lines. The total weight of a full-sized car is about 10 tons, made up somewhat as follows: car and propelling gear, 4 tons; batteries, 2½ tons; passengers, 3½ tons. If the 3½ tons represented by the passengers were utilised for additional storage cells, the car could run 20 miles with the loss of 10 per cent. of its charge; or it could run 200 miles if losing the whole of its charge. As there are, however, only 2½ tons of batteries instead of six tons, it can only run 86 miles. This is according to the table, and more than attainable in practice, for the reasons already stated. Experience has shown that storage cars can only run from 30 to 60 miles with one set of batteries, or half the distance stated in the table. If we apply the same reduction to all the methods of transmission, we find that the distances to which power can be carried electrically in the stored form, with an efficiency of 90 per cent., are two, five, and 18 miles over a carriage road, tramway, and railway respectively.

The efficiency of transmission is, however, not the only or even the most important consideration in the problem of transmitting power to a distance. The owner of a transmission plant cares nothing for any theoretical perfection in the way of high efficiency. All he cares for is the cost at which the power is delivered to him. All other things being equal, high efficiency will naturally reduce this cost, and in so far is an advantage, but in practice all other things are not equal, and to aim at high efficiency regardless of other considerations is the reverse of good engineering. It is no doubt gratifying to the engineer if he can point to a transmission plant designed by him to give some extraordinarily high efficiency, but if this result has been obtained by means of an exorbitant capital outlay and excessive working expenses, it will not be equally gratifying to his employer, the owner of the installation, who has to pay for its erection and working. It therefore becomes the duty of the engineer so to plan the installation that the cost of the power delivered shall be a minimum under any given circumstances.

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* Cantor lectures delivered before the Society of Arts.

We have seen that, as judged by the efficiency standard alone, electric transmission of power in the stored form is hopelessly behind the other two methods which we compared with it. Let us now see whether this is or is not the case if we judge the system by the more practical, and, indeed, the only reliable test of cost. It is of course understood that in estimating the annual cost at so many pounds per horse-power delivered, we take into account not only the cost of coal burnt throughout the year, if we obtain the power by steam, or the rent for water, if we use a turbine, but also all other expenses which may properly be charged to the power account, such as wages for the attendants, petty stores, interest, repairs, and depreciation of plant. Estimated in this way, the cost of water power will be found to vary between £2 and £8 per annum, the exact figure depending, of course, on the total amount of power available, the quantity of water, its fall and local conditions, which must largely influence the cost of the hydraulic works. The cases where water power can be had at so low a price as £2 a year are exceptional; on the other hand, if we have to pay as much as £8 a year for water power, it will seldom be worth while to transmit it electrically, or in any other way; and I shall therefore assume £3 and £6 as the limits of cost for water power intended for electric transmission. The cost of steam power, if produced by large economical engines, is generally taken at £10 per year; if produced by small, and therefore less economical engines, it may rise to £20, and even £40 per year. I shall further assume that in all cases the power is required for 3,000 hours during the year—that is, 300 work days of 10 hours. At the outset it is clear that if we wish to transmit large parcels of power—say, 100 h.p. and upwards—by storage batteries, we must be able to deliver the power at a cost not exceeding £10 a year; for were the cost higher, it would obviously pay better to establish a local steam engine. I have already mentioned that a system of battery transmission can be made to yield 56 per cent. efficiency, if we allow 10 per cent. for the transmission itself. To deliver 100 h.p. we must, therefore, charge with 178 h.p. during a time equal to that during which the power is required. If, therefore, at the generating station the annual horse-power costs £3, the charge for power alone will be £5. 6s. at the receiving station. To this must be added the cost of labour and the interest and depreciation of plant, which, in this case, consists of the generating dynamo, motor, batteries, and line of transmission, with its equipment of locomotives and waggons. The small storage cells, as now made, for lighting and power purposes, cost about £40 per horse-power; but let us assume that the larger cells, such as we would require, could be had for £30 per horse-power, then a battery to work a 100-h.p. motor would cost £3,330. In order to economise carriage, and to reduce the wear and tear of cells, it would be advantageous to have two batteries, one being charged while the other is at work. We have thus an initial outlay of £6,660 for batteries alone. The interest and depreciation on these will certainly not be less than 15 per cent., or £10 per horse-power. Add to this the cost of power at the generating station, that of labour and interest and depreciation on the electric machinery and the line, and you will see that it is quite impossible to compete with battery transmission against a local steam engine, if the power produced by the latter costs £10 per annum. But how does the case stand, if the amount of power required is so small that it cannot be produced at this low figure. If we want only 5 h.p., and if we produce it by a local steam or gas engine, we shall have to pay for each horse-power £20 to £40 per annum. Will it in this case pay to transmit by means of batteries the power produced by a large and economical steam engine at some central station? If we have to build a tramway or railway for this purpose specially, it will certainly not pay; but let us assume that a tramway already exists, and let us investigate whether the company, which we suppose is working the line by storage cars, could afford to sell to a customer on the line power at a cheaper rate than he could produce by a local engine. Let us assume, by way of example, that the customer requires 5 h.p. for 10 hours daily. The battery to work a 5-h.p. motor will weigh about 2½ tons, and cost £170. The charging dynamo, motor, and regulating gear will cost about £150, so that the whole capital outlay, if we provide two batteries, will amount to £490.

Now let us see how such a system of transmission will have to be worked, and what the working expenses will be. I take, by way of example, five miles as the distance between the generating station, which may be the tramway depot or a central electric light station on the line of tramway, and the delivery station. At either terminus we must have mechanical appliances for loading and unloading the batteries from the car, such as are generally used in connection with storage cars. Early in the morning a charged battery is put on the car, and run out to the delivery station, where it is unloaded and connected to the motor. The other battery which has served during the previous day, is loaded on the car and taken back to the depot to be charged up again. In this manner the car need only make one journey out and one journey home daily. As its speed may be very moderate, say from three to four miles an hour, the cost of running this car will be much less than that of a passenger car, which must stop and start every few minutes, and run at a higher speed. I take 3d. per car mile as the cost of haulage, including the use of plant, and I further allow 2s. a day for labour in loading and unloading the batteries. The account of working expenses will now stand somewhat as follows:

Power at generating station at £10, allowing 65 per cent. total efficiency*	£77	0	0
Haulage	37	10	0
Labour	30	0	0
15 per cent. interest and depreciation on batteries (340)	51	0	
10 per cent. interest and depreciation on electric machinery (£150)	15	0	0
Total annual cost	£210	10	0

This works out at £42. 2s. per annum per horse-power delivered, and is therefore quite as high, if not higher, than the cost of power obtained by a small and uneconomical local engine. On the score of economy there is consequently no advantage in transmitting power by storage batteries in the present case, where the distance of transmission is five miles. Had the distance been less, the working expenses would also have come out smaller, but not by any considerable amount. The only item in which we could save is cost of haulage, and if we neglect this altogether we have still to pay £34s. 12s. per annual horse-power delivered. Battery transmission can therefore not compete against power produced by a local engine, even if the latter be of the rather uneconomical type which users of small power still tolerate. But how stands the case if for some local reason the employment of a heat engine of any kind is precluded? We have then the choice between electric transmission by means of batteries, and directly by means of a pair of wires. Which will be the more economical? As the dynamo and motor, except, perhaps, in the matter of voltage, will be the same in either case, the answer to this question turns upon the comparison of the batteries and line of wires. The first question to consider is whether our wires may in the case of direct transmission be carried overhead on poles and insulators, or must be put underground. If the former be the case, the line need not cost more than £130 per mile; and I may at once mention that from the experience gained with various power transmissions, which I hope to bring before you, this item can be estimated with a fair degree of accuracy. As I shall have to deal more in detail with the cost and construction of live power transmission plants later on, I shall not enter into details at present, and must ask you to take my statements as to cost of line and cost of power transmitted as correct, though I do not now show how the account is made up. As regards transmission by wires placed underground, there is, as far as I know, no example of such an installation, and we can therefore not verify our estimate by reference to work actually executed, as we can in the case of overhead transmission. We are thus forced to calculate the cost of the line according to the data obtainable for electric light mains, and I take for this purpose an estimate made by Mr. Crompton in his paper on "Central Station Lighting," read before the Institution of Electrical Engineers on the 12th of April, 1888. In this paper Mr. Crompton gave tables for the cost of underground mains of various types and sizes, and by reference to his tables I find that a main of the section required for the transmission of 5 h.p., and insulated so as to safely bear a pressure of 1,000 volts, would cost about £670 per mile. We have now all the necessary particulars for making a comparison of the cost of transmission and direct transmission, the latter by both overhead and underground wires. The following table gives the result. The cost includes the charge for power at the generating station (taken at £10 per annual horse-power), and interest and depreciation on the plant, which is taken at 15 per cent. for the batteries, and 10 per cent. for the line and electrical machinery.

TRANSMISSION PLANT FOR 5 H.P.

Distance of transmission in miles.	Annual cost per horse-power delivered, if the transmission is		
	By batteries.	Direct.	
		Overhead.	Underground.
	£	£	£
1	36·1	22·8	33·6
2	37·6	25·6	47·2
3	39·1	28	60
4	40·6	30·6	74
5	42·1	33	87

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* In this case the efficiency is the ratio of the power supplied to the charging dynamo to that obtained from the motor, and does not include power spent in transmission, being charged for in the account at 3d. per car mile.

We see from this table that if there is no objection to an overhead line, the electric transmission of stored power by means of batteries cannot compete against the direct transmission of live power by means of a pair of wires, even if the distance is considerable. But in towns we cannot have, or at least we ought not to tolerate, overhead lines, and if we work with an underground line we find that, for distances exceeding one mile, the battery is a more economical transmitting agent than the wire. Here we have at last found a case where it will be advantageous to transmit power by means of storage batteries, but there are so many conditions attached to the case that the field of application of such a system must necessarily remain very limited. First, the power must be required, so to say, in small parcels; secondly, there must be a tram line handy, and the customers must have facilities for loading and unloading the batteries and accommodating them on his premises; thirdly, there must be a charging station on the line having similar facilities; fourthly, the use of an overhead line must be excluded; fifthly, the distance must exceed one mile; and, finally, there must be some reason why a local engine cannot be used. I need hardly point out that a system of transmission fenced in by so many conditions cannot have any commercial importance. Thus far, the result of our investigation is entirely negative. We find that transmission of power by means of storage batteries, whether the power transmitted be large or small, is not so economical as other methods of transmission, and has, therefore, no commercial value for all cases where these other methods are applicable. If I have, nevertheless, devoted some part of this lecture to the subject of battery transmission, it was because the idea of distributing power, so to speak, bottled up in batteries, seems to have a fatal charm for many inventors. It is an old idea, but is always coming up again, and for this reason I thought it advisable to go a little into figures and show you how the case really stands. It might, perhaps, be objected that as no distribution of stored power by means of ambulant batteries has as yet been practically introduced, it is premature to give an opinion as to the possibilities of such a system. The idea of battery distribution of power is, as a matter of fact, entertained not only by amateur electricians, but also by practical engineers. As an example of this fact, I may quote a passage in a report written about two years ago by Mr. J. F. Fanning. This gentleman, reporting to the Cataract Construction Company on the question of utilising the power of Niagara Falls, says: "Power and lighting currents may be electrically transmitted to neighbouring cities, and possibly storage batteries may be electrically charged and recharged, and many times forwarded for use in surrounding cities." When writing this, Mr. Fanning had, of course, in view cheap water power, and probably canal transportation. If, at the same time, batteries could be made cheaper, lighter, and more durable than they actually are at present, then, but not until then, will they become commercially possible as transmitting agents in competition with other systems of power transmission. Taking batteries as we find them at present, their use as agents in the transmission of power is only justifiable in cases where the direct transmission by means of conductors cannot be employed; and this brings me to the consideration of the only case of the electric transmission of stored power which, as yet, has attained to practical importance—namely, the use of batteries for locomotive purposes.

Although electric tramcars come, strictly speaking, within the title of my lectures, I do not propose to consider them at any length, the reason being that this branch of power transmission alone, if treated in detail, would absorb all the time at my disposal. I shall, therefore, content myself in taking up the subject only so far as is necessary to show in a general way what is the present practice in this branch of power transmission.

We have in this country two very good examples of battery tramcars, the one being the cars now running in Birmingham, and the other the cars on the Barking-road line in the north of London. Of the former I have not been able to obtain much information, but of the latter I have, by the kindness of Mr. T. Fraser, who superintended the erection and working of the plant, been able to obtain all the information required for my purpose. I am also indebted to Mr. Reckenzaun for information regarding his cars, which are in use at Philadelphia. The accompanying table gives the principal data of these cars conveniently arranged for comparison and reference.

Taking the averages of the last two lines in the table, we find that for a car representing a total rolling weight of 10 tons, we require a battery capable of giving a maximum output at its terminals of 19 e.h.p., and a mean output of 5·6 e.h.p. It must, however, be noted that the latter figure applies to the time the car is actually in motion, and does not include the power wasted in starting. Mr. Fraser has made very careful observations of the power flowing out of the batteries during the whole of the time the car is in service, and found that the integrated power divided by time comes to 7·33 e.h.p.; that is say, a motor taking from the batteries all day long 7·33 e.h.p., will take from the batteries the same amount of power that is actually taken under the intermittent work going on in the running of a tramcar. Of the 7·33 e.h.p., a good motor will yield about 6½ b.h.p. Taking the efficiency of the batteries at 60 per cent., a figure by no means too low when we consider the very irregular nature of the work done by these batteries when in service, we find that the electrical horse-power of the charging dynamos required per car is about 12 e.h.p. The ratio between the indicated power of the engine and the output of the charging dynamo may be taken at 80 per cent., so that we shall have to provide engine power at the rate of 15 i.h.p. for every car, provided the engines are worked for the same number of hours that the cars are in service. If the engines are worked for a longer time, say by night as well as by day, a corresponding reduction in the total indicated power of the station can of course be made.

STORAGE BATTERY TRAMCARS.

—	Birmingham.	Barking-road.	Philadelphia. Small car.	Philadelphia. Large car.
Weight of car (in tons)	—	3·275	2·500	3·620
Weight of motors and gear (in tons)	—	1·360	·980	1·140
Weight of batteries (in tons)........... ...	2·850	2·460	1·770	2·450
Weight of passengers (in tons)...............	3·300	3·600	2·230	3·600
Total rolling weight (in tons)...............	10·50	10·63	7·48	10·81
Percentage of paying load........	31·5	34	30	33·2
Number of cells	96	96	84	116
Maximum current ..	—	70	70	80
Maximum energy at battery terminals (electrical horse-power)	—	19	14	23
Average energy at battery terminals (electrical horse-power)	—	6	4·8	5·4
Maximum energy per 10 tons of rolling weight (electrical horse-power)...... ...	—	17·8	18·7	21·3
Average energy per 10 tons of rolling weight (electrical horse-power).........	—	5·65	6·42	4·95

Returning now to the subject of the cost at which stored power can be retailed by electric transmission to small consumers, let us briefly glance at the rival system—namely, the distribution of small parcels of live power from a central electric light station. One hears it often stated that the supply of power, and not that of light, must become the chief business of such stations. The argument in support of this view is somewhat as follows: The demand for light is very uneven, being less than a tenth of the capacity of the station for many hours during the day, and rising very rapidly towards evening. The period of large demand comprises only a few hours, and during that time the engines work with great economy. During the remainder of the day the economy is less; and, in fact, the greater portion of the coal bill, cost of attendance, and interest on the capital outlay is chargeable to light running. If, therefore, by the sale of power, we could keep the central station plant economically working during the whole of the day, the increase in the working expenses would be slight, but the increase of revenue would be very considerable. This argument is perfectly sound, but it has the rather serious defect that it will not convince the very people from whom this large increase of revenue is to be obtained; for, let us see what it means to the user of power. As you know, electric current is supplied from central stations, at a charge varying from 4½d. to 8d., and even 1s. per Board of Trade unit. The usual charge in London is about 7d. Now, suppose a small manufacturer, requiring only a few horse-power, determines to discard his small steam or gas engine, and put up an electromotor, to be worked by current from a central station, what will the power cost him? This, of course, depends on the time—that is, the number of hours in the year during which he requires power. If he has a small factory, in which work is steadily going on day by day, you may estimate that the power will be required during 3,000 hours per annum. It is now very easy to calculate the annual cost of each brake horse-power. Allowing £1. 10s. per horse-power for depreciation and interest on the motor, and £1 for petty stores, we find that, at 7d. per unit, the annual horse-power comes to £75. With current at a different price, the cost of power will be accordingly altered, as shown in the table:

POWER DERIVED FROM A CENTRAL STATION.

Cost of Board of Trade unit	d. 1	d. 2	d. 3	d. 4	d. 5	d. 6	d. 7	d. 8
Cost of annual brake horse-power for 3,000 hours ...	£ 12·9	£ 23·3	£ 33·5	£ 43·9	£ 54·2	£ 64·5	£ 75	£ 85·4

It is clear from this table that the small user of power will only use an electromotor if he can get current at about 3d. per unit, and, unless electric light companies can supply at this price (which at the present time does not seem likely) there is no prospect of supplying electric power to small factories wanting the power continuously. Another disadvantage is that the demand for power must, in winter at any rate, overlap the demand for light, thus requiring the erection of additional plant. If, however, the power is only required intermittently, then the electromotor is by far the cheapest instrument for producing it, not only as regards first cost, but also as regards working expenses. There are many small trades in which power is wanted only for a few hours during the day. If, for instance, the actual running time of a lathe is two hours daily, then the cost of the annual horse-power, with current at 7d., would only be £15, a figure which cannot be touched by either steam or gas. There is the further advantage of having the power always ready. There is no need to get up steam, look to the feed pump, open cylinder cocks, turn the engine over the centre, and generally do the dozen little things which are required in starting an engine. With a motor, all that is required is to turn on the switch when the power is wanted, and to turn it off again when the job is done. For domestic purposes, again, nothing could be more handy and economical than electric power supplied from a central station. I have here a collection of appliances, for the loan of which I have to thank the Keys' Electric Company, and I can show you how easy and convenient it is to apply electric power to small domestic machinery.

I have in the present lecture dealt with what may be termed general questions of engineering policy rather than with technical details, and I am afraid you will have found the financial parts of the lecture rather a dry subject. The question of cost is, however, of the utmost importance in engineering work, and it was therefore necessary to give it some consideration. In the remaining two lectures I shall be able to turn to the more interesting parts of our subject, and bring before you some of the scientific principles and technical details relating to the electric transmission of live power over long and short distances.

ELECTRIC TRAMWAYS.

Some time since Mr. Frederick Brown, A.I.E.E., was requested to report to the Walsall Corporation on electric traction. Mr. Brown visited America, and carefully examined into the equipment and working of many of the tramways, and upon his return reported to the Corporation. After referring to the various lines inspected, he sums up his conclusions in the following manner:

There are three styles of carrying the overhead wire, which is known as the trolley wire.

1st. Where there are two lines of rails, centre poles are used with an arm on each side carrying the wire. These would not be suitable for our streets and roads; though in wide roads they do not look very bad. In our roads they would be in the way, and a dangerous obstruction.

2nd. Where the tram lines are laid at the side of the road or street, poles with an arm are used, carrying the trolley wires over the centre of the track.

3rd. Lighter poles are erected on each side of the street, and a wire called a span wire (which is not used for conveying electricity, but only as a means of support) is stretched across, and the electric or trolley wire is hung from that over the centre of the track. This is by far the most convenient: and in the American roads, where trees are planted on each side, is the least unsightly, and is, all things considered, I think the most suitable for use here, as our streets vary in width, thus varying the distances from the rail to the kerb, which would, if the second plan named above be used, necessitate the arms on the poles varying in length, which I fear would look very unsightly. At junctions and corners there is some complication, which is certainly no ornament to the streets, but it is entirely a matter of opinion. I find that the public in America prefer the eyesore of the wires to horse or steam power; the noise and smoke of the latter they much object to.

I submit various photographs for your inspection, and am expecting others.

Other wires than the trolley wire are necessary for bringing the power to the various sections of the trolley wire. These are called feeders, and are carried on insulators attached to the poles that carry the span wires.

In important streets I should advise these being put underground, but outside the centre of the town they might be run as is usual in America.

The speed of the cars is regulated by the city authorities, and varies on different roads from six to 12 miles per hour, though the latter is often much exceeded outside the cities.

The electric cars are safer than the ordinary cable car, as they can be run in either direction at will, and so can back out of danger if necessary, and the danger of the grip getting caught in a broken strand of a cable, and so the driver losing the power of stopping, is avoided.

The speed can be varied at will, from a crawl to 30 or more miles per hour. There is complete absence of jerk in starting, the suddenness of the stop of course being in the hands of the driver, who can, if necessary, stop within a car's length when going at full speed.

At first there was some trouble with joints in the trolley wire giving way, but this appears to be a thing of the past, as improved means of jointing have been introduced.

Much of the overhead work in America has been done in a hurried manner, and could be made much neater and safer with more care and time being spent upon it. This point should be insisted upon if the system be allowed here.

I found no complaint from interruption to ordinary traffic from the wires, they being high enough for all loads to pass under, excepting some special cars belonging to a circus, the wires preventing the emblematic characters from riding on the top.

In America the wires are carried about 19ft. from the ground. They should be rather higher here to allow of our fire escape passing under. The American escapes are carried horizontally.

In cases of fire the firemen cut the wires down if necessary, the current being cut off from that section—telephones being fixed in the power stations for the purpose of giving notice, or a system of electric signals is used.

I have, for your inspection, a number of reports from various bodies on the subject, among which you will find letters from a number of mayors of cities in which overhead wires are in use.

In reply to the points on which you requested me to obtain special information I beg to state:

1st. Duplicate lines of rails are not necessary unless required by the traffic.
2nd. The existing lines of rail will need some alteration—viz., each rail needs connecting to the next by a strong copper wire riveted into each, and they also need electrical connection across. Earth-plates should also be put in at times, as it tends to lessen the action on the telephone.
3rd. Posts may be on one or both sides of the road.
4th. The posts are not complained of.
5th. The posts are about 40 yards, or 120ft., apart.
6th. The posts can be used for carrying other wires and for carrying electric lamps, and could be used for sewer ventilation.
7th. The roads are mostly lighted by electricity, some with gas, and some with oil.
8th. The poles are to be so fixed as to be safe, and the wires to be not less than 19ft. high.
9th. No special rule as to distances from kerb. The narrowest street I saw was 20ft. 6in. wide, and it had a 4ft. 6in. track in centre. This street had two tracks in it, but the tram people altered it, as it delayed their traffic, the cars not being able to pass a standing cart or waggon.
10th. The arms project to centre of track.
11th. No objection is raised excepting by circus proprietors.
12th. Horses seem to take no notice. I only saw one case of restiveness.
13th. Cars work either way, and do not need to be turned.
14th. A bell has to be rung on nearing a cross road, and head lights are carried. The driver rings the bell with his foot, thus leaving both hands for the brakes if necessary.
15th. The cars passing each other, or passing a crossing, must always sound a bell.
16th. Authorities limit the speed from six to 12 or more miles per hour. The driver has complete control.
17th. I heard of no complaints, though at times they have them from what they term the abutters—*i.e.*, persons whose property abuts upon the street in which the lines of rail are laid.
18th. The width of pavement varies so much that I can give no measurements.
19th. The wires are mostly carried overhead—some are underground.
20th. The wire is fixed to an insulator at the terminus, and is above the heads of the public.
21st. There is no danger to human life.
22nd. The posts vary in thickness and material, some being wood, some iron tube, and some lattice work in iron; the base being about 6in. to 8in.
23rd. Unless the improved motors are used the noise is objectionable. With the improved motors and gear I heard of complaint of their not making noise enough.
24th. There is at times a little sparking visible which might frighten a horse, but I failed to hear of a case, and as our roads are better than the American, this flashing would be reduced.
25th. The narrowest road I saw was about 20ft. 6in. The widest was 120ft.
26th. There are streets where telegraph, telephone, and electric light wire posts are fixed, with the poles for the cars. They are fixed any how that seemed best to the men who put them up, and want some regulations in this respect.
27th. Sign-boards and other projections have been allowed, but are being removed pretty fast by the authorities, though many remain.
28th. There are from one to six lines on some of the poles.
29th. The tramways are worked by private companies and not by the authorities.
30th. I found no case in which the authorities had any right to use the tramways for public purposes without paying for such use.
31st. Their fire escapes are run horizontally and they have no trouble, though if a wire is in the way they cut it down.
32nd. The maximum potential is in use now, and the usual one is 500 volts.

I may state, in conclusion, that the use of the system is muc increasing, there being on order in the works that I visited some 2,000 motors.

REPORT ON INSPECTION AND TESTS OF BROWN'S PATENT ROTARY EXPANSIVE ENGINE.

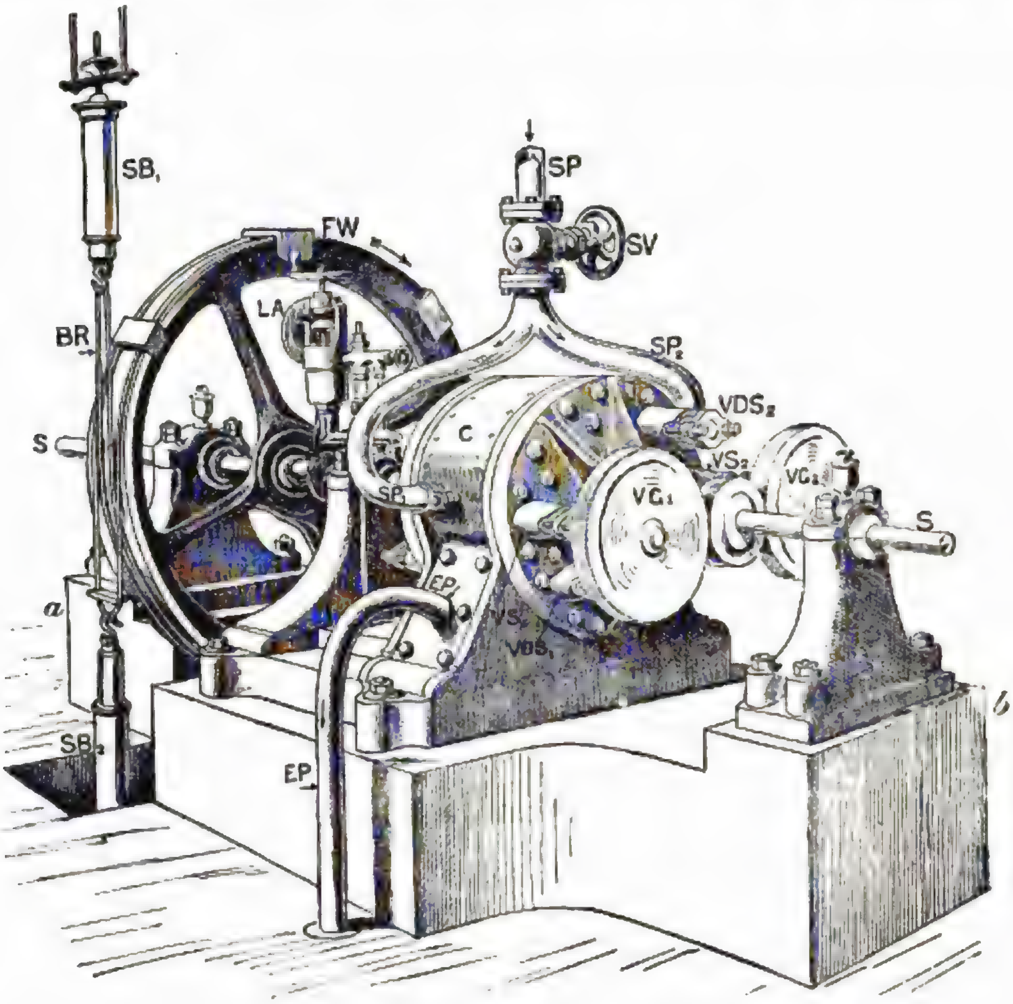
BY PROF. JAMIESON, M.I.C.E., F.R.S.E., ETC.

The following is the expert's report to the makers upon this engine:

Having been requested by you to test and report upon your latest improved rotary engine, I went to Messrs. Lang and Son's tool works, Johnstone, on the morning of Wednesday last, the 27th May, with two assistants, where I found the boiler, engine, and all the necessary instruments in perfect order.

General Description of Engine and Brake Gear.—Before giving the details of my tests I will describe briefly the general features of your engine and the brake gear adopted by aid of the accompanying photo-lithograph from a freehand sketch made by Mr. J. H. Oswald Brown, artist, on June 4th, prior to my taking the second set of indicator cards.

Details of Cylinder and Valves.—The chief points of novelty about your engine are the cylinder, piston, and valves. The cylinder is only 10·5in. diameter by 8·625in. in length, or 746·9 cubic inches. The cross area of the piston is 40·5 square inches, and its length is 8·625in., or 349·3 cubic inches, so that it occupies nearly one-half of the volume of the cylinder.



Brown's Rotary Expansive Engine with Brake Gear, as Tested by Prof. Jamieson.

S P, steam-pipe from the locomotive boiler; S V, stop valve; S P_1, S P_2, steam-pipes branching to each rotating steam admission valve; C, cylinder; V G_1, V G_2, valve gearing for working the steam admission valve; V S_1, V S_2, valve spindles to which V G_1, V G_2 are keyed; V D S_1, V D S_2, (oscillating) valve door spindles; E P, exhaust pipe; L A, lubricating apparatus; S, S, shaft to which piston, etc., are keyed; F W, flywheel, 4ft. diameter, specially fitted for taking the B.H.P. of the engine; B R, brake ropes; S B_1, S B_2, Salter's (spring) balances.

The cylinder receives steam twice during each revolution of the piston from two cylindrical rotating valves fixed to the valve spindles, V S_1, V S_2, which are placed diametrically opposite to each other, and respectively between the steam-pipes, S P_1, S P_2, and the cylinder valve doors. The valve spindles are driven by the valve gearing, V G_1, V G_2, from a pinion keyed to the central shaft, S. They can be adjusted so as to cut off the steam at any desired point of the piston's revolution, or they may be connected to a governor so as to maintain a uniform speed under widely different variations of load and steam pressure.

Two oscillating valve-doors, keyed to the spindles, V D S_1, V D S_2, form part of the circumferential working surface of the cylinder when they are closed. They are alternately opened by the incoming steam pressing behind them whenever the peculiarly shaped piston has passed them, and owing to your effective mode of cushioning the steam between them and the rotating valves, they are closed gently by the piston during the time of exhaust. The front edges of the valve-doors form a continuous steam-tight joint with the rotating piston in such a manner that the reaction due to the steam pressure between their back faces and the effective area of the piston causes the latter to revolve. The higher the piston speed, the greater is the economy of steam. The steam, after being cut off by the rotating valves, expands, doing work until it exhausts through the axle bosses of the oscillating valve-doors.

Preliminary Inspection and Verification of Apparatus.—I carefully measured the volume of the boiler water supply tank, and found it to be 305lb. for every barrel full, checked the brake spring balances by Government stamped standard weights, saw that the brake ropes were properly adjusted, and found the radius of the brake load, *r*, to be 2·0417ft., which gave the logarithm of the constant, etc., for brake horse-power $\left(\log \frac{2\pi r}{33{,}000}\right) = \overline{4}{\cdot}5895$.

log. of constant .. .. $= \overline{4}{\cdot}5895$
log. of mean brake pull, 93·2lb. $= 1{\cdot}9694$
log. of mean speed, 574·5..... ... $= 2{\cdot}7593$

log. of mean B.H.P., 20 8 ...... $= 1{\cdot}3182$

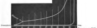
Trial Run, Periodical Observations.—With steam shut off from the engine, the feed-water was forced into your locomotive multitubular boiler by the injector, until it reached a definite mark (about half glass) on the polished brass scale, fixed immediately behind the gauge glass. The water supply tank was then filled up to an overflow hole, and the steam pressure raised to 93lb. by steam gauge. The engine was started at 2.15 p.m., at a speed of 560 revolutions per minute, and then simultaneous observations were taken every 15 minutes of the boiler pressure, net brake load, and the revolutions per minute by Messrs. Schaffer and Budenberg's tachometer (the accuracy of this instrument I had previously ascertained), from which the brake horse-powers have been calculated. The whole of my observations have been inserted in the accompanying table exactly as they were written down at the time, and the means taken from a continuous run extending over five hours' duration.

From this table it will be seen how very steadily the engine maintained its speed, and how the power developed by it gradually rose from a minimum of 18·6 B.H.P. to a maximum of 22·39 B.H.P., as the working parts warmed up. Had I been certain that the brake wheel (which was 4ft. in diameter, with light arms), could have withstood a higher speed than 600 revolutions per minute, there would have been no difficulty, as far as the engine itself was concerned, in increasing the speed to 800 or even 1,000 revolutions per minute, as both the material and workmanship seem to be of excel-

BRAKE HORSE-POWER TESTS OF BROWN'S ROTARY ENGINE.

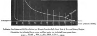
No. of reading.	Time P.M.	Boiler pressure by gauge.	Net brake load.	Revs. per minute.	B.H.P.	Remarks.
		lb.	lb.			
1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Each barrel full of feed-water = 365lb.
2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2.30 p.m., 1st barrel into boiler.
3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3.25 p.m., 2nd barrel into boiler.
6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3.45 p.m., 3rd — —
7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4.10 p.m., 4th — —
9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4.30 p.m., 5th — —
11	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
12	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5.5 p.m., 6th — —
13	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Engine very steady. Brake working splendidly.
14	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5.25 p.m., 7th barrel into boiler.
15	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5.45 p.m., 8th — —
16	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6.10 p.m., 9th — —
17	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6.30 p.m., 10th — —
18	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
19	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6.50 p.m., 11th — —
20	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	7.20 p.m., 12th — — 7.40 p.m., 13th — — less 16lb.
	Means =	95	[illegible]	[illegible]	[illegible]	Total feed-water used in 5 hours = [illegible] Gross feed-water per hour = [illegible] — — per B.H.P. hour = [illegible] — — per I.H.P. hour = [illegible]

Right Hand. Diagram No. 3. Boiler pressure = [illegible] by gauge. Scale spring 1" = [illegible]. Taken [illegible] p.m., [illegible].



Indicator Card taken at [illegible] Revolutions per Minute from the Right Hand Side of Brown's Rotary Engine.

Left Hand. Diagram No. 4. Boiler pressure = [illegible] by gauge. Scale spring 1" = [illegible]. Taken [illegible] p.m., [illegible].



Indicator Card taken at [illegible] Revolutions per Minute from the Left Hand Side of Brown's Rotary Engine.

Calculation for indicated horse-power and feed-water per indicated horse-power hour.

$$\text{I.H.P.} = \frac{\text{PLAN}}{33{,}000} = \frac{[illegible]}{33{,}000} = [illegible]$$

Gross feed-water used per hour = [illegible] Gross feed-water per I.H.P. hour = [illegible]

but quality, and the only oscillating parts are the valve doors, which are duly cushioned during their back strokes, and always kept bearing upon the rotating piston by steam acting from behind them. [illegible] doubt that the consumption of steam per brake horse-power hour would have been still less than it was—viz., a mean of 37·9lb. per brake horse-power. A considerable condensation of steam no doubt took place in the steam-pipe, and in the two long indicator pipes, which were not lagged. The fall of pressure between the boiler and the cylinder, as shown by a comparison of the pressure gauge, and the indicator cards, amounting to fully 15lb. on the square inch, is due to the steam-pipe being small, right-angle bends, and the non-effective water trap. From the indicator cards taken by me prior to commencing the brake horse-power trial of five hours, as well as from those taken by me subsequently on June 4, the gross consumption of steam is only 27·2lb. per indicated horse-power hour; results which surpass not only any other rotary engine, but equal those of the very best simple expansion, fast speed, non-condensing engines (of the same power, run at the same speed and with the same steam pressure), with which I am acquainted or have seen recorded.

The indicator diagrams were taken with M'Innes' fast-speed indicator, and they are remarkably good. They show an almost equally effective power developed by the steam admitted through each rotating valve and cylinder door. The steam efficiency is only 70 per cent. of what it would have been had you been supplied with perfectly dry steam, for it appears from the indicator cards that only 19lb. of dry steam of 95lb. absolute pressure was recorded by them per indicated horse-power hour to the point of cut off, instead of an actual weight of feed-water equal to 27·2lb. per indicated horse-power. Or, 30 per cent. of the feed-water passed into the cylinder as water with the steam. The mechanical efficiency of the engine and combined heavy brake wheel and gear, or ratio of brake horse-power to indicated horse-power was 71·6 per cent., but as you will only require a small flywheel and two bearings less in the engine you make for actual work, the mechanical efficiency will no doubt then be quite equal to 80 per cent.

After steam was shut off from the engine at 7.15 p.m. feed-water was injected into the boiler until it reached the same mark on the gauge glass scale with which we started the trial run, and the feed-water barrel was filled up to the overflow hole. From these data I found that the engine had used a total of 3,948·5lb. of water during the five hours, or 789·7lb. of water per hour, which is equivalent to 37·9lb. per brake horse-power hour and 27·2lb. per indicated horse-power hour.

These results corroborate the five hours' continuous tests taken by you on May 19 last. I can account for your getting the slightly better result of 37·27lb. feed-water per brake horse-power hour from the steam-pipes leading to the indicator being left on and unjacketed throughout my trial; whereby not only a certain amount of heat energy was dissipated by radiation, but also a percentage of steam was wasted due to this additional clearance. In fact, the initial clearance appears to have been doubled by keeping these long indicator pipes on during my brake horse-power trial.

Condition of Engine after the Brake Horse-power Trial.—I had the right-hand cylinder cover removed after the five hours' run, and found all the working surfaces in perfect order. Not only were the original tool marks everywhere visible, but a fine hard glossy skin was coming up on all the wearing parts Both the workmanship and material are excellent, and bear out the good name attained by the makers, Messrs. John Lang and Sons, for accuracy and finish. I was particularly taken with the various self-adjusting packing strips between the sides and end of the piston and the cylinder, whereby you had so adjusted the compressive reaction of the back springs that the wear should take place evenly. The arrangements for renewing them (should occasion require the same to be done at any time) are exceedingly convenient and simple.

Improved Engine.—The present engine, although the fourth or fifth which you have made according to your patent, will, I understand, be still further improved upon in the one now being manufactured, by having a live steam jacket completely surrounding the cylinder and thus dispensing with the branch steam-pipes, SP_1, SP_2, as shown on the accompanying figure. It will consequently be more compact, and by having the valve gearing covered in, and the small flywheel overhung on the further side, the whole engine will be placed on one firm cast-iron sole-plate.

Space occupied by Engine.—The space occupied by your engine is less than that of any reciprocating steam engine of the same power with which I am acquainted.

Cases in which the Engine may be applied.—Your engine will be found most useful in working electric lighting and transmission of power dynamo machines, where a high speed, space, and uniformity of action are important qualifications. Also for driving yachts, steam launches, centrifugal pumps, fans, and gas exhausters, etc.

Indicator Cards.—The following two cards, selected out of a large number taken by me from the right and the left hand sides of your engine, with different strengths of springs, on June the 4th, speak for themselves. They are reproduced full size, and the necessary data has been printed on and beneath them. The mean pressures, found by ordinates in the usual way, were checked by Amsler's planimeter, which gave a slightly higher mean pressure of 30·8lb. per square inch for the two cards. The effective area of piston was taken as 29·11 square inches, the effective stroke as 1·86ft., and the revolutions as 574·5 per minute, being the mean revolutions per minute observed during the five hours' brake horse-power trial, which numbers were used in calculating the indicated horse-power. The cards were, however, taken at only 200 revolutions per minute, as it was found impossible to get an even admission line at higher speeds owing to the excessive vibration of the too long indicator pipes and the reaction of the indicator spring.

COMPANIES' MEETINGS.

EASTERN TELEGRAPH COMPANY.

Report of the Directors for the half-year ended 31st March, 1891.—The Directors submit the accounts and balance-sheet for the six months ended 31st March, 1891. The revenue for the period amounted to £383,306. 18s. 2d., from which are deducted £102,020. 10s. 4d. for the ordinary expenses and £53,144. 9s. 6d. for expenditure relating to repairs and renewals of cables, etc., during the half-year. After providing £2,274. 12s. 9d. for income tax, there remains a balance of £225,867. 5s. 7d., to which is added £78,195. 6s. 5d. brought from the preceding half-year, making a total available balance of £304,062. 12s. From this amount there have been paid:

	£	s.	d.
Interest on debentures and debenture stock	28,274	13	2
Dividend on preference shares......	20,474	3	1
An interim dividend of 1¼ per cent. on the ordinary shares	50,000	0	0
	£98,748	16	3

Leaving a balance of £205,313. 15s. 9d., from which £95,000 has been carried to general reserve. The Directors now recommend the declaration of a final dividend for the year ended 31st March, 1891, of 2s. 6d. per share and a bonus of 3s. per share, amounting together to £110,000, both payable on the 16th inst., free of income tax, and making, with the three previous payments on account, a total distribution of 13s. per share, or 6½ per cent. for the year on the ordinary shares. The balance of £313. 15s. 9d. shown at the foot of the revenue account is proposed to be carried forward to the next half-year. The revenue includes £33,283. 4s. dividends and bonus for the half-year upon the Company's investments in the Eastern and South African, the Black Sea, the Direct Spanish, and the African Direct Telegraph Companies. The agreement with certain of the Australasian colonies for the reduction of rates between Europe and Australia having been concluded, the new rates were brought into operation on 1st May last, and the increase of traffic is encouraging. The laying of the triplicate cable between Aden and Bombay, referred to in the last report, was completed by the contractors on 19th April last. The operations for duplicating the Suez-Suakim section, referred to in the last report, were successfully completed on 10th March last.

The thirty-eighth half-yearly ordinary general meeting of the Company was held at Winchester House on Thursday, the chairman, Sir John Pender, K.C.M.G., presiding.

The **Chairman** stated that the receipts from messages during the six months ended March 31 last showed an increase of £1,125 over the corresponding period of last year. The working expense for the same period showed an increase of £3,343 over last year, but included in this year's figures was a special item for repairs to the Alexandria buildings of £3,825, necessitated by dry rot appearing. Their ships had been put into thoroughly efficient order, and were ready for work at any moment. As to their staff endowment insurance fund, which amounted to £2,366, as against £1,688 last year—up to last year a certain number of their staff had taken advantage of this insurance scheme; but the Directors, after 10 years' experience, were so convinced of its advantages that they had asked the remainder to join, and nearly the whole of the staff were now contributing members. It was their policy to get the best men, and to make them as comfortable as possible in order to keep them. There was an increase in repairs and renewals of cables of £5,000. The chief expense had been in connection with the Red Sea cable, laid in 1870. They had removed all weak parts, and laid in new cable. Here was a cable that had been worked for 21 years, as against the 10 years which was once given as the life of a cable. Referring to the Red Sea cable, and the new triplicate cable to Bombay, he said it had always been their policy to keep ahead of the carrying requirements of the Company, and it was satisfactory to be able to say that the encouraging results of the traffic since the reduction of rates to Australia had fully justified the foresight and prompt action of the Directors. They had also duplicated their line to Suakim. Notwithstanding these important and extensive operations of cable laying, they did not propose any permanent addition to the capital account, but hoped to be able to meet these expenses by appropriation from time to time out of reserve fund. This policy of keeping down the capital, and keeping up the power to pay annual dividends was the secret of the strength of that Company. With the temporary assistance of the Eastern and South African Company, in which they held 59-60ths of the share capital, they would be able to meet the payments due to the Telegraph Construction and Maintenance Company. The financial transactions would take about four years to complete, and at the end of that time it was estimated that the additions to their cable system would have been paid for, and the whole amount applied out of reserve fund. It was reckoned that the amount taken out of the fund up to the completion of these arrangements would be about 1½ million sterling, and the balance remaining to reserve would be about half a million. The Company would therefore be in a better financial position than it was to-day. They had expended in repairs of cables 709 knots, and the ships who effected these repairs had sailed 112,189 knots. They now had all their cables duplicated. They had four cables betwixt Suez and Aden; three betwixt Aden and Bombay; and their total cable mileage was 26,093 miles against 8,434 in 1870, which practically was the capital involved in that concern, and this had been attained without in the slightest degree interfering with their dividends. At the same time they had materially added to their reserve fund—that he thought was a state of things with regard to their property, that would be very difficult indeed to beat. Their African traffic last year was £49,000 less than it was two years ago, when there was a great deal of excitement there, and communication between the Cape, Kimberley, and London was very active indeed. For the moment this mining companies' traffic did not exist, but the legitimate traffic had been increasing, and the time would come round again, because there were cycles of activity and of rest, and the latter was prevailing at the present moment. There was no doubt at all that the Cape was one of the future countries to which they would have to look for a largely increased consumption of British merchandise. In a certain period these African cables would be the property of the Eastern Company, and this item would add largely to their producing power, without increasing their capital. The increase of traffic, owing to the reduction of the Australian rates, had been very satisfactory on the whole. They had not recouped themselves entirely, and he didn't expect to do so within 18 months or two years. But they had so far recouped themselves, that when the end of the year came they were very likely to carry on the experiment. The Cape had applied to be put on the same footing as Australia, but that required some negotiation. He would like to see one experiment thoroughly tested before they entered upon another. In conclusion, he alluded to his recent visit to the Mediterranean stations, and to the good order in which he found them, as well as the happy relations which existed between the Turkish and Grecian Governments and the Company's officials. He then moved the adoption of the report and accounts, and declaration of the dividend (*vide* report).

This was seconded by the **Marquis of Tweeddale**, and carried unanimously.

In answer to a shareholder, the **Chairman** said that the latest of the three cables between Aden and Bombay was laid to the southward of the others.

A vote of thanks to the Chairman, proposed by **Mr. Griffiths**, concluded the proceedings.

CHILI TELEPHONE COMPANY.

The ordinary general meeting of this Company was held on Tuesday at Winchester House, Colonel R. R. Jackson presiding.

The **Chairman** stated that the gross revenue of the Company had increased from £26,310 to £38,711, or 47 per cent., and the working expenses from £15,996 to £19,506, or only 22½ per cent. The cost of working had fallen from 61 per cent. upon the gross revenue to 50 per cent., and with the increase of the gross revenue and the diminution of the expenditure, the net revenue showed an increase from £10,314 to £19,205, or 86 per cent. Had it not been for the fall in the exchange of 25 per cent., the earnings would have been equal to 8½ per cent. upon the capital. Sufficient profit was made to pay a dividend at the rate of 7 per cent. per annum, but, taking into consideration the state of affairs in Chili, the Directors thought it wise to carry the whole amount forward. The number of subscribers had increased by 965. The expenditure on development in Valparaiso and Santiago had been very heavy. At the outbreak of the civil war the Government took over the business, but would compensate the Company in respect of any loss. He moved the adoption of the report and accounts, which was duly seconded and carried.

TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY.

The half-yearly general meeting of this Company was held on Tuesday, at the offices, 38, Old Broad-street, Sir George Elliott, M.P., presiding.

The **Chairman** stated that during the last six months they had been employed principally in completing contracts entered into in 1890—that was, in finishing the manufacture of and in laying the Eastern Company's cables between Aden and Bombay, and the Eastern Extension Company's cables between Madras and Penang. Both of these operations were successfully carried out in the months of March and April last. Their cable factories were still at work completing a contract for the Great Northern Company. Their general current business continued to be satisfactory. They only went into the question of their accounts once a year, and that was the whole of the business of the meeting that day.

The meeting then separated.

COMPANIES' REPORTS.

DIRECT UNITED STATES CABLE COMPANY.

The half-yearly report of this Company states that the half-year's revenue, after deducting out-payments, amounted to £37,352. 19s. 5d., against £40,017. 1s. for the corresponding period of 1890, being a difference of £2,664. 1s. 7d., against the half-year under review. The working and other expenses for the same period, exclusive of cost of repairs of cables, amounted to £18,112. 19s. 8d., leaving a balance of £19,239. 19s. 9d. as the net profit of the half-year, making, with £5,510. 11s. 3d. brought forward from the previous half-year, a total of £24,750. 11s. For the corresponding period of 1890 the working expenses and other payments amounted to £17,616. 5s. 8d. Three quarterly interim dividends of 3s. 6d. each per share, amounting to £31,872. 15s., have been declared and paid during the financial year, and a final payment of 3s. 6d. per share is now proposed, making, with the three interim dividends, 3½ per cent. for the year, being a total distribution of £42,497. The balance of £3,502. 1s. on the revenue account is proposed to be carried forward.

EDISON AND SWAN UNITED ELECTRIC LIGHT COMPANY.

Directors: James Staats Forbes, Esq., chairman; Frederick Richards Leyland, Esq., deputy-chairman; Viscount Anson; Shelford Bidwell, Esq., F.R.S.; Ernest Villiers, Esq.

Report of the Directors to be presented to the shareholders at the annual meeting to be held at the Westminster Palace Hotel, Victoria-street, S.W., on Tuesday, July 21, at 12 o'clock.

The Directors have the pleasure of presenting to the shareholders their report and the accounts for the year ending June 30, 1891. The business of the Company has resulted in a credit balance of £72,905. 4s. 7d., out of which the Directors have appropriated the sum of £3,425. 14s. 8d. to meet loss on realisation of dynamo account, taken over at the amalgamation; and £12,371. 14s. 7d. has been absorbed by the payment of an interim dividend on the A shares at the rate of 7 per cent. per annum for the first six months of the year. The Directors recommend the payment of the following dividends on the A shares, free of income tax, and to be distributed in accordance with clause 87 of the articles of association: (*a*) At the rate of 7 per cent. per annum for the half-year ending June 30, 1891 (making 7 per cent. for the year). (*b*) 3 per cent. in completion of payment of arrears of cumulative preference dividend for the year ending June 30, 1885. (*c*) 7 per cent. in payment of arrears of cumulative preference dividend for the year ending June 30, 1886, which will absorb £47,719. 10s. 7d., leaving £9,388. 4s. 9d., which the Directors have carried to the reserve fund, in accordance with clause 89 of the articles of association. The Directors have granted licenses to several electrical firms and companies to manufacture holders and sockets for incandescent electric lamps under the Company's patents. This branch of the business will increase as electric lighting increases, and will bring a satisfactory addition to the revenue of the Company. Mr. J. S. Forbes and Mr. F. R. Leyland retire from the Board in rotation, and offer themselves for re-election as directors. The auditors, Messrs. Welton, Jones, and Co., retire, and are eligible for re-election.

PROFIT AND LOSS ACCOUNT FOR THE YEAR ENDED 30TH JUNE, 1891.

Dr.	£	s.	d.
Stock on hand, 1st July, 1890	56,266	8	10
Wages, purchases, etc.	56,362	19	6
Salaries, Directors' remuneration, rent, office expenses, insurance, income tax, general and law charges	15,270	6	7
Depreciation on plant, etc.	2,160	18	10
Balance	72,905	4	7
	£202,965	18	4

Cr.	£	s.	d.
Sale of lamps, fittings, royalty on holders, etc.	143,229	14	11
Interest, etc.	427	12	0
Stock on June 30th, 1891	59,308	11	5
	£202,965	18	4

BALANCE-SHEET, JUNE 30, 1891.

Dr.	£	s.	d.	£	s.	d.
Share Capital—5,000 A shares of £5 each, fully paid, allotted to the Edison Electric Light Company, Limited	25,000	0	0			
12,139 A shares of £5 each, fully paid, allotted to the Swan United Electric Light Company, Limited, ranking up to 5 per cent. for dividend on the amount credited as paid up, and afterwards equally, per share, with A shares partly paid	60,695	0	0			
89,261 A shares, £5 each, £3 paid	267,783	0	0			
23,564 B shares, £5 each, fully paid	117,820	0	0			
				471,298	0	0
The B shares are entitled to one-fourth of the profits, after a cumulative preferential dividend of 7 per cent. per annum has been paid on the A shares. (The preferential cumulative dividend of 7 per cent. amounted, on June 30, 1891, to £82,491 12s. 4d.)						
Sundry credit balances				14,706	19	4
Reserve fund				12,689	0	3
Profit and loss as per appropriation account	69,479	9	11			
Less interim dividend at the rate of 7 per cent. per annum for six months ended December 31, 1890, paid on February 20, 1891	12,371	14	7			
				57,107	15	4
				£555,801	14	11

Cr.	£	s.	d.	£	s.	d.
Cost of patents, goodwill, preliminary outlay, loss on working, etc., as per last balance-sheet ...	236,022	18	10			
Further expenditure thereon	2,041	13	5			
				238,064	12	3
Deduct loss on realisation of original dynamo account taken over at the date of amalgamation, and heretofore reckoned amongst capital outlays	3,425	14	8			
	234,638	17	7			
Amount of B shares of this Company, issued as *per contra*	117,820	0	0			
				352,458	17	7
Manchester Edison-Swan Company, Limited, £100,000 B shares at nominal cost				12,000	0	0
Freehold property..........				45,012	10	3
Plant and stock........................				83,188	11	0
Office furniture				231	3	6
Debtors				34,859	1	9
Investment in Consols at cost				20,000	0	0
Cash at bankers and in hand				8,051	10	10
				£555,801	14	11

STATEMENT SHOWING THE PROPOSED APPROPRIATION OF PROFITS.

	£	s.	d.	£	s.	d.
Amount transferred to capital account to meet loss on realisation of original dynamo account taken over at the date of amalgamation and heretofore reckoned amongst capital outlays				3,425	14	8
Dividend for the year ending 30th June, 1891, at 7 per cent. per annum (of which £12,371. 14s. 7d. was paid as interim dividend on 20th February, 1891)	24,743	9	2			
Payment of the balance of cumulative preferential dividend on the A shares for the year ending 30th June, 1885, at the rate of 3 per cent.	10,604	6	10			
And payment of cumulative preferential dividend on the A shares at the rate of 7 per cent. for the year ending 30th June, 1886......	24,743	9	2			
Reserve fund.....................	9,388	4	9			
				69,479	9	11
				£72,905	4	7

CITY NOTES.

Brazilian Submarine Telegraph Company.—The receipts for last week were £4,883.

City and South London Railway.—The receipts for the week ending 11th inst. were £692, against £719 for the preceding week.

Globe Telegraph Company.—The Directors propose to pay a balance dividend of 4s. 6d. per share, and to carry over a sum of £1,876.

The Eastern Extension Company announce the payment by warrant, on Aug. 1 next, of the interest for the half-year ending July 1 on their 4 per cent. mortgage debenture stock.

Western and Brazilian Telegraph Company.—The receipts for the week ended July 10, after deducting 17 per cent. of the gross receipts payable to the London Platino Company, were £3,363.

PROVISIONAL PATENTS, 1891.

JULY 6.

11447. **Improvements in electric arc lamps.** H. Dudley Norman and H. A. Payne, 29, Dorchester-place, Blandford-street, London.

11473. **Improvements in alternating-current electromagnetic motors.** Henry Harris Lake, 45, Southampton-buildings, London. (Nikola Tesla, United States.) (Complete specification.)

11476. **An improvement in key or switch sockets for electric lamps.** Reuben James Bott, 33, New Bridge-street, Blackfriars, London.

JULY 7.

11497. **An hydro-electric lift.** James McLaren, Public Library, Edinburgh.

11519. **Improvements in diaphragms for electric cells.** Ernest Arthur Le Sueur, 47, Lincoln's-inn-fields, London. (Complete specification.)

11526. **Improvements in and connected with portable electric lamps, and in primary batteries and lenses for deflecting light to be used therewith.** Frederick George William James Adams, 1, Quality-court, London.

11538. **An electric traction magnetic conductor.** George Prokofiew, 13, Alkerden-road, Chiswick.

11539. **An improved dynamo machine.** George Prokofiew, 13, Alkerden-road, Chiswick.

11560. **Improvements in and relating to galvanic batteries.** George Gatton Melhuish Hardingham, 191, Fleet-street, London. (John Randolph Hard and Henry Connett, United States.)

JULY 8.

11601. **Improvements in phonautographic and phonographic "forms" or material for the recording of sound vibrations.** Charles Adams-Randall, 3, Woodstock-road, Bedford Park, London.

11620. **Improvements in apparatus for preparing bleaching solution and bleaching powder by electrolysis.** Emily Eliza Lever, 77, Chancery-lane, London.

11625. **Improvements in the method of and apparatus for making electrical connections.** John Henry Holmes, 6, Lord-street, Liverpool.

11630. **Improvements in and connected with moulds, rolls, or dies for manufacturing metallic plates or boxes, the said plates or boxes being more especially intended for use in electrical secondary batteries.** Anthony Spencer Bower, 47, Lincoln's-inn-fields, London.

11644. **Improvements in the lighting of trains by electricity.** Illius Augustus Timmis, 2, Great George-street, Westminster, London.

11645. **Improvements relating to combination gas and electric fittings, and to gas fittings.** Richard Brown Evered and Thomas Rudling, 45, Southampton-buildings, London.

JULY 9.

11668 **Electric lighting of ships' compasses transparent cards.** John Parkes, 43, Canning-place, Liverpool.

11712. **Improvements in or connected with electric batteries.** Henry Clay Bull, 57, Chancery-lane, London.

JULY 10.

11720. **Improvements in electrical switches.** John Henry Tucker, 2, Gordon-place, Erdington, Warwickshire.

11746. **Improvements in telegraphic apparatus.** Frans Van Houten, Monument-chambers, King William-street, London. (Complete specification.)

11756. **Improvements in electrical railway signalling.** William Brock and William Henry Radcliffe Saunders, 22, Southampton-buildings, London.

11767. **Improvements in telephone switchboards.** John Edward Kingsbury, 24, Southampton-buildings, London.

JULY 11.

11801. **Improvements in the manufacture of insulating conduits or coverings for electric conductors.** Robert D. Haines, 23, Southampton-buildings, London. (Date applied for under Patents Act, 1883, Section 103, 12th December, 1890, being date of application in United States.)

11804. **A mechanical liqueur telephone.** Henry Paul Ade, 16, Bendler-street, Berlin.

SPECIFICATIONS PUBLISHED.

1890.

9683. **Electrically driven percussive tools.** Atkinson. 8d.

13359. **Electrically propelled cars.** Siemens Bros. and Company, Limited. (Siemens and Halske.) 8d.

1891.

5508. **Electro-plating wire.** Hemming. 6d.

8141. **Insulated electric conductors.** Thompson. (Williams.) 8d.

8183. **Electric alarm, etc.** Fitzpatrick. (Schubardt.) 8d.

8540. **Electric railways.** Moore and Warren. 6d.

8575. **Generating, etc., electric energy.** Tesla. 8d.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Brush Co.	—	2½
— Pref.	—	1½
India Rubber, Gutta Percha & Telegraph Co.	10	19½
House-to-House	5	5
Metropolitan Electric Supply	—	10
London Electric Supply	5	2
Swan United	3½	4½
St. James'	—	7
National Telephone	5	5
Electric Construction..............	10	7¼
Westminster Electric..................................	—	5

NOTES.

Richmond.—Tenders for wiring Richmond Town Hall, if sent, must be sent in by August 4.

Bournemouth wants the opinion of an electrical engineer as to lighting its pier with electric light.

Aylesbury.—The tenders for public lighting must be sent in by the 31st inst. to Mr. G. Fell, Aylesbury.

Writing Telegraph.—When Prof. Elisha Gray's writing telegraph becomes practical, "autogram" is proposed as the word to use.

Palermo Exhibition.—The contract for five dynamos for lighting the forthcoming exhibition at Palermo has been given to Messrs. Siemens and Halske.

Accumulator Patent.—The judgment given against M. Paul Gadot with reference to accumulators has been confirmed in the French Superior Court.

Burnley.—A new infirmary is to be erected at Burnley. Mr. Keighley, the architect, should be supplied with material for estimating the inclusion of electric light.

Colombo Tramway.—It is thought that the Contract Construction Company, who have the new tramway in Colombo in hand, will use compressed air as the motive power.

Northampton.—Messrs. Jeffery and Holden, architects, have given the contract to decorate the Northampton Town Hall to Messrs. Campbell and Smith. Electric light should be included.

Blackburn.—A new orphanage is being built at Wilpshire, Blackburn—architects, Messrs. Briggs and Wolstenholme—a possible opening for gas engine and accumulators.

North London.—The promoters of the North London Electric Lighting Order having failed to comply with certain conditions, the order has been revoked by the Board of Trade.

Cromwell-road. — Consent of the London County Council has been given to the extension of mains in Gloucester-road and Cromwell-road by the Kensington and Knightsbridge Company.

Harlow.—Tenders are invited for the public lighting of Harlow, from Sept., 1891, to April, 1892, from dusk to 11 p.m., and cleaning and storing lanterns. Particulars of Mr. W. E. Deards, Broadway, Harlow.

Electric Tramways in Norway.—A syndicate was recently formed in Christiania for the introduction of an electric tramway, and a deputation has visited Berlin, Frankfort, and Halle to report upon the systems there in use.

Austrian Telegraphs.—A universal telegraph tariff has been arranged between Austria and Germany. The charge is 3 kreuzer (·6d.) per word, with a minimum of 30 kreuzer (6d.). This tariff will come into force at the beginning of 1892.

Lighting an Artillery Encampment.—The Monmouthshire Artillery Brigade go into camp at Abergavenny on Tuesday next, and the annual inspection takes place on Bank Holiday. The camp will be lighted by electricity, the current being supplied by the Risca batteries.

Double Filament Lamp.—Herr Hiel, in the *Elektrotechnisches Echo*, No. 28, describes an arrangement for series incandescent lighting, of an incandescent lamp with two filaments, combined with an automatic switch to come into action on the failure of the first filament.

Telegraph Extension.—In answer to a question, Mr. Raikes stated in the House of Commons that by an amendment in the Post Office Bill, of which he has given notice, power will be given to local authorities to guarantee the cost of extensions of telegraph wires in districts in which they may be needed.

The Royal Society of Edinburgh.—The last ordinary meeting of the session of the Royal Society of Edinburgh was held on Monday at the Royal Institution, Lord M'Laren in the chair. A paper was read on the "Effect of Longitudinal Magnetisation on the Interior Volume of Iron and Nickel Tubes," by Prof. Knott.

Huddersfield.—The Gas Committee of the Huddersfield Corporation reported to the County Council on Wednesday that they met on the 1st inst. and decided to accept the amended tender of the Brush Electrical Engineering Company, Limited, for the installation of the electric lighting in Huddersfield at a cost of £20,640.

Saunderson Arc Lamps.—With reference to the use of hydrocarbon vapour in arc lamp carbons, and Dr Hopkinson's and Prof. Thompson's remarks there—anent, the *Bulletin de l'Electricité* hopes some third electrician will take up the question, and demonstrate whether the presence of gas on the arc is really an advantage or the reverse.

Thunderstorms.—Severe thunderstorms were experienced throughout the country at the end of last week. At Coventry the chimney of a large house was cut off level with the roof. At Nuneaton the flagstaff on Messrs. Hall and Phillips's hat factory was cleared as if by a hatchet, one half remaining, while the other half fell and damaged the roof.

Swindon.—The New Swindon Local Board have had the consideration of the Electric Lighting Acts before them. The question was left to obtain further particulars. Mr. A. D. Williams wrote to state his intention to lay down a dynamo and engine, and asked permission of the Board to take a wire across the street at the level of the present telephone wire. The Board acceded to the application.

London Chamber of Commerce.—A meeting of the council was held on Monday, Sir A. Rollit, M.P., presiding. A deputation of the Chicago World's Fair was introduced by Sir P. Cunliffe Owen, and was promised support. A deputation from the telephone companies was next received on the subject of an improved service, which was referred to a committee of the Chamber for further investigation.

Paddington.— Letters were read at last week's meeting of the Paddington Vestry from the Paddington and Bayswater Electric Light and Power Supply, Limited, and the London Electric Lighting Company, Limited, announcing their intention respectively of applying for a provisional order to supply electricity in this parish. It was decided to instruct the solicitor to oppose in both cases.

Ship Lighting.—Sir William Thomson in an interesting letter to the *Electrical Review* points out that, as regards disturbance of ship's compasses, the concentric wiring has no advantage over the one-wire system unless the outer sheathing is insulated sufficiently to prevent the return current spreading over the ship. A moderate degree of insulation, such as mounting on dry wood, would be sufficient.

Goole.—Tenders for lighting are required, for 12 months, from September 30, by the Goole Local Board. Gas is asked for, but electric light might also be acceptable. Mr. G. England is the clerk, and tenders are wanted by August 11. Goole is to have new goods offices for the Lancashire and Yorkshire Railway Company. The various tenders will be received by Mr. C. W. Bayley, Hunts Bank, Manchester.

Edison Patents.—The case brought by the Edison Electric Light Company against the United States Electric Light Company for infringement of a patent again came before the United States Courts on Tuesday, when Judge Wallace granted a suspension for 15 days of the injunction ordered by him against the latter company pending an appeal, on condition of the defendants giving a bond to protect the Edison Company in the event of the appeal being dismissed.

Sutton (Surrey).—The Sutton General Purposes Committee recommended that, subject to a satisfactory agreement with Messrs Girdlestone and Co., no opposition be offered to any application by them for an order to furnish electric light in Sutton, as proposed by them. The recommendation was opposed, it being suggested that the Board should obtain the powers themselves. Ultimately it was resolved the question be considered by the whole Board acting in committee.

Electric Mining Plant. — A new and complete system of American electric mining plant, consisting of coal cutters, rock drills, stone and granite cutters, is being introduced by Messrs. Shippey Bros., of London, who announce that they are prepared either to sell machines right out, free from royalty, or to contract with colliery and quarry proprietors to cut coal, stone, or granite at a fixed charge upon the output. Particulars and drawings of these machines will be published shortly.

Schuckert Transformer.—Messrs. Schuckert, of Nuremberg, have brought out a new type of transformer, illustrated in the *Elektrotechnische Zeitschrift* for July 17. Imagine a heavy flat ring of iron, deeply grooved towards the centre hole to half its depth with 12 channels, making it somewhat of the form of Mordey's alternator magnet, but flat. Each of the 12 oblong cores thus made are wound with coils, the whole making a flat ring transformer. Considerable advantages are claimed from this shape of transformer.

Chelsea Electric Lighting Bill.—In the House of Lords, Lord Basing's Committee, on Thursday last week, declined to insert a clause in the recommitted provisional order relating to the electric lighting of St. Luke's, Chelsea, giving the County Council any control. This decision is one of considerable importance, as it sets aside the principle contained in all former London electric lighting bills in which the London County Council have concurrent jurisdiction with the local authority in regard to electric lighting.

St. Paul and Minneapolis Railway.—Is not the St. Paul, Minneapolis, and Manitoba Railway Company which is coming before the British public this week for £1,000,000 mortgage bonds just exactly that company on whose line (between St. Paul and Minneapolis) the trains have ceased running, owing to the vigorous opposition of the electric railway? The line spoken of is probably only a small length, but that a line is already forced to give up such a service by reason of this opposition is suggestive of troubles to come.

Mr. Sprague's Challenge.—Mr. F. J. Sprague, the well-known American electric railway engineer, has recently published a challenge to the world, in which he offers, under certain conditions, to produce an electric locomotive of greater capacity than any yet made. He proposes to take a train of six elevated railroad cars loaded, weighing, without the motive power, about 108 tons, to haul this train at a maximum speed of not less than 40 miles an hour on the level, on two miles of track on certain designated railway lines in New York.

Torpedo Work.—Those interested in torpedoes, electric mines, and the blowing up of ships will find an interesting article thereon by M. Georges Dary in *L'Electricien* for July 18. An illustration is given of an officer watching the progress of vessels in a *camera obscura*, ready to touch the contact which is to explode the mines. Another arrangement shows a range-finder and exploder—two telescopes with contacts, which when both are one the vessel makes contact for the sunk mine over which she is passing. The contacts and arrangements are shown in diagram.

Salford.—Tenders are required for lighting the Ladywell Sanatorium by an electric light installation, for the County Borough of Salford. Applications for specifications, accompanied by a deposit of £1. 1s. (which will be returned upon receipt of a *bonâ fide* tender), to be made to Messrs. Maxwell and Tuke, or Messrs. E. and F. Hewitt, architects, Manchester. Tenders, endorsed "Electric Lighting," addressed to the chairman of the General Health Committee, must be delivered to Mr. Samuel Brown, town clerk, Town Hall, Salford, by 11 a.m. on 30th inst.

Telephone Cables in the City.—At the meeting of the Commissioners of Sewers last week, Mr. Sayer presented a report of the Streets Committee relative to an application by the National Telephone Company to place a portion of their telephone cables beneath the public ways, the committee stating that, in their opinion, it was inexpedient to give consent to the application of the company to use the subsoil of the City until the contracts lately entered into for electric lighting purposes have been carried out. The recommendation was agreed to without discussion.

North London Tramways.—Negotiations are in progress for the transfer of the lines of the North London Tramways Company to the North Metropolitan Company. The London County Council have agreed to guarantee undisturbed possession until 1910, provided that the use of steam be discontinued, and that if other mechanical power be adopted it shall be subject to the same conditions as the North Metropolitan line. The North Metropolitan Company are intending to expend £25,000 in putting the road in order and introducing better methods and service.

Dover.—At last week's meeting of the Managing Committee of the Dover Town Council, the town clerk said he had received two replies to the advertisement for tenders for supplying the electric light to Dover. The first was not a tender in accordance with the requirements of the Council. It was from Messrs. Reed Bros., and offered to supply electric light to the town for the Council. The other tender, which was in proper form, was from the Brush Electrical Engineering Company, and the proposal contained very lengthy details The question was left over to a special meeting.

Helston.—Carlow is already becoming a catchword for councillors on the electric lighting question. Helston (Cornwall) pays £195 a year for gas, and, says Mr. Cade, if Carlow can have its electric light from water power five miles off, Helston could surely do it with water power only one and a half miles away. Mr. Veale, of St. Austell, had written to the Town Council to give information as to the electric lighting of that town, and a committee was eventually appointed to invite Mr. Veale to visit Helston, and to consult generally upon the advisability of electric lighting the streets and public buildings.

Underground Electric Line for Paris.—We at the Highway Committee of the Paris Municipal has decided in favour of the construction subterranean electric tramway from the Bois de logne to the Bois de Vincennes, passing under the oulevard Diderot, the Rue de Rivoli, the Place de la Concorde, and the Avenue des Champs Elysées. The cheme is the proposal of M. Bertier, and proposes an nderground tubular line, similar to the South London line. t would be lighted by incandescent lamps.

Brixton.—The "Bonanza" General Stores at Brixton re splendidly lighted by electric light, and are simply a laze at night, the light being as steady as possible. The Electric-avenue is also being lighted up with arc lamps, and ltogether this part will be the best lighted thoroughfare in ondon when completed. Messrs. Clark, house furnishers, ave also their place magnificently lighted, and seem to be upplying current for several other shops round about. Opposite is the "Bon Marché," which has long been ighted electrically. This corner of the metropolis is well vorth a visit from electrical engineers.

Carbon Transmitters.—Mr. A. R. Bennett, writing to he Manchester papers, and referring to the recent warning dvertisement of the National Telephone Company, says: 'This announcement is calculated to do harm to my company, nd I therefore request you to be good enough to enable ne to state that the National Company's advertisement is nisleading. The Mutual Telephone Company are provided vith an efficient carbon transmitter, which they will put n use on July 31, and which has been submitted to eminent olicitors and patent agents, and pronounced altogether ree from any patents which the National Telephone Comany may retain possession of after July 30."

Sanitation and Electric Light.—The substitution of electric lighting for gas at the office of the Savings Bank Department of the General Post Office, as Mr. Preece as often urged in its favour, has been followed by a narked reduction in the amount of sick leave among its mmense staff of employés. The *Lancet* believes this tatement to be substantially correct, and observes "an electric lamp does not compete for the oxygen of an partment in which it is placed, and this circumstance gives t a marked advantage over any open flame. It cannot, ike some forms of gas burner, be used to promote ventilaion; but in ordinary situations its harmlessness is a much more important property."

Pilsen Lamps and Carbons.—The Pilsen Electric Company have removed their offices and works from 4, Stanhope-street, Euston-road, N., to more central and extensive premises, 80, Leather-lane, Holborn. Their new works are being specially arranged for the manufacture of Pilsen arc lamps and all accessories for electric lighting and transmission of power. Several new forms and adaptations of the Pilsen lamps suitable for lighting the interiors of buildings are being prepared for the market, and also an improved kind of carbon for use with arc lamps, which are stated to show marked advantages over the carbons hitherto used. Of these further information and details will be given at no distant date.

St. Pancras Exhibition.—We are glad to learn that the St. Pancras electrical exhibition turned out a decided success financially, and the surplus is to be applied to reducing the charges to exhibitors made by the authorities for space. The beauty, interest, and success of this little exhibition is greatly to the credit of the promoters of it, and should lead to similar local exhibitions elsewhere. There was not too much to be seen, all was interesting and much of it moving or in action, the decorations were well laid out, the colours tasteful, and the rooms well decorated with palms and flowers. It was quite as interesting to the public as to the technical man, and as such achieved the success it deserved.

College Sessions.—No sooner do the last year students pass through their examinations and receive their certificates, than a new batch of scholars come forward to be provided for. Parents begin to think of sending their boys and earnest young men to turn their attention to the technical classes. England now, if not in buildings, yet in practical and earnest men, and useful laboratories, can vie with the Continent in technical education. Notices of the next year's courses at the City and Guilds Colleges at South Kensington, under Profs. Henrici, Unwin, Ayrton, and Armstrong, and at Finsbury under Profs. Thompson, Perry, and Meldola, and at University College under Profs. Ryan, give particulars of the electrical and mechanical courses for the ensuing session in October next.

Street Transformer Boxes.—A decision of some importance to electrical suppliers has just been made by the London Council. The London Electric Supply Corporation recently gave notice of intention to construct a street box, with connections, in Coventry-street. The company proposes to construct a box, which would be 5ft. square and 6ft. high inside, with a cover in the footway about 2½ft. square, and to place two transformers therein, a cellar which has hitherto been used for this purpose being no longer available. The Highways Committee are of opinion that such an interference with the public thoroughfares should not be sanctioned, and that the company should make some other arrangement. They therefore recommend that the Council do disapprove of the works referred to.

Lighthouses.—In reply to Dr. Cameron, in the House of Commons on Tuesday, Sir M. Hicks-Beach said, in compliance with an application of the Commissioners of Irish Lights, the Trinity House and the Board of Trade have sanctioned an increase in the power of the light at the Old Head of Kinsale by the substitution of a 10-wick burner for the present four-wick burner. They have declined to sanction the suggested installation of the electric light at this station, as they are advised that the position is neither a "salient headland" nor an "important land fall," as specified in the report of the Trinity House on the South Foreland experiments, and that therefore the very large expenditure of establishing an electric light station could not be justified. No application for a fog signal is before the Board of Trade.

Cardiff.—At the meeting of the Lighting and Electrical Committee of the Cardiff Corporation, on Tuesday, it was announced that the electric lighting order for Cardiff had received the Royal assent on the 3rd inst. On the motion of Mr. Carr, seconded by Mr. Peter Price, it was unanimously resolved that a committee, consisting of the chairman and vice-chairman of the committee and the borough engineer, be appointed to gain information as to the methods with regard to electric lighting which were adopted in other towns, and that they engage the services of an electrical expert in connection with their enquiry. There were two courses open to the Lighting Committee—to manufacture the electric light themselves, or to farm out their powers to some company on certain terms. The name of Mr. Carr was also added to the committee.

Fire Brigade Electric Bells.—As the period during which Messrs. Binko and Co. undertook to maintain the electric bells belonging to the London Fire Brigade will shortly expire, the Fire Brigade Committee have obtained the tenders for the maintenance of the bells for a period of three years. They think that if the contract be let for one year only the tendency will be for the contractors to do just enough to the bells to prevent their breaking down altogether, whereas if the contract be for three years it will be to the contractors' interest to pay better attention to them. The tenders are as follows: Messrs. Binko and Co., £123. 15s.; Mr. R. Colston, £175; Mr. J. Sax, £395; and Messrs. Pyke and Harris, £500 per annum. They recommend that, subject to an estimate being submitted by the Finance Committee, the tender of Messrs. H. Binko and Co. be accepted.

Strand.—The sanction of the London County Council is given to the laying of mains in Duke-street, Adelphi, and Villiers-street, Exeter-street, Suffolk-street, and Burleigh-street, Strand, of the Electricity Supply Corporation (Gatti's), upon condition that the company give two days' notice to the Council's chief engineer before commencing the work in any of the thoroughfares specified in the notices; that the work in the Strand, when once commenced, shall be carried on continuously by day and by night; that the mains shall be laid under the footways wherever it is found practicable to do so; that the concrete floor of the road boxes be made 9in. thick; that the York stone at the top be 4in. thick; that the longitudinal girders on all the boxes be laid in 3in. stone templates the full thickness of the brickwork; and that the whole of the works shall be completed within the shortest time possible.

Arc Lamps at St. Pancras.—The Electricity Committee reported to the St. Pancras Vestry at their meeting last week that they had given consideration to the description of arc lamp columns, and lamps required for the public lighting of Tottenham Court-road Various tenders have been received, and it has been necessary to suggest certain modifications in order to limit the cost. The lamps are, of course, the most important item, and the committee have determined to adopt the Brockie-Pell arc lamps, of which Messrs. Johnson and Phillips are the sole manufacturers, and this firm will also supply the lamp columns. The committee recommend that they be authorised to purchase and fix 26 arc lamps and columns, as already approved by the Vestry, at a cost not exceeding £38 per lamp, including lamp, fixing, column, and all necessary appliances connected with the lamp. The report was carried.

House-to-House Mains.—The London County Council having received notice from the House-to-House Electric Light Supply Company of intention to lay mains and to construct two street boxes in Pembroke-road, Earl's Court-road. The proposed works are unobjectionable, and they recommend that the sanction of the Council be given to the works referred to, upon condition that the company do give two days' notice to the Council's chief engineer before commencing the work; that the mains shall be laid under the footways wherever it is found practicable to do so; that the street boxes to be used shall be of the pattern approved by the Council; and that as an additional precaution against accident through defective insulation of the mains, each of the street boxes shall be provided with an inner as well as an outer cover, each insulated from the other as far as practicable, and that the outer cover shall be efficiently connected with earth.

Burton-on-Trent.—The Corporation of Burton-on-Trent are prepared to receive tenders for an efficient system of electric lighting suitable for adoption in certain specified streets in the borough, and for the construction and erection of a central station for generating electricity, and for supplying and laying down the necessary electrical wires, insulators, etc., in accordance with the system proposed. A map of the borough, showing the site on which it is intended to erect the station, and the streets in which the mains will be laid, may be seen, and a form of tender, with copy of conditions and general specification of the work required to be done, may be obtained on payment of two guineas (which will be returned on receipt of a bona fide tender), on application to Mr. F. L. Ramsden, engineer, Gas Works, Burton-on-Trent. Sealed tenders, endorsed "Electric Lighting," are to be delivered to Mr. T. N. Whitehead. town clerk, Burton-upon-Trent, by 10 a.m. on 29th August.

City Lighting.—At the last meeting of the Commissioners of Sewers the clerk read a letter from the Brush Electrical Engineering Company relative to the lighting by electricity of Queen Victoria-street. In their communication the company undertook to light the street with 26 arc lamps, which would be in lieu of 96 gas lamps. Mr. Sly asked who would pay for the gas during the time. The chairman said the Commissioners always arranged with the gas companies under such circumstances. Mr. Sayer said he thought he ought to explain that the cost to the ratepayers would be about £150 extra. The gas must be paid for during the making of experiments with the electric light which were, of course, necessary. The subject then dropped.—It may be interesting to state in connection with this subject that measurements have been made under the superintendence of Mr. Preece, who is conjoint adviser to the Commissioners with Colonel Haywood, of the candle-power of the electric lighting. The result, which was approximate, went to show that the average illumination was about five times that of the old gas lamps.

Goldsmiths' Institute.—The Goldsmiths' Technical and Recreative Institute, New Cross, was opened on Wednesday by the Prince and Princess of Wales, and was the occasion of anticipations of much usefulness for the project. The institute is furnished with a useful electrical laboratory. The latest and most improved appliances have been supplied for ventilating by Messrs. Easton and Anderson, who have put down one of their improved electromotors, driving a Blackman fan, for supplying fresh air to the lecture halls. A "Whitehall" dynamo (Prentice's patent) is placed adjoining the electrical laboratory, and supplies current to the electromotor. It has also been proposed to work the bellows of the grand organ, shortly to be erected, by electromotors, controlled by the organist with magnetic clutches. The "Whitehall" dynamos are driven by the steam engine used for pumping and other purposes, and this installation will be an interesting example of how power may be electrically distributed for a variety of purposes throughout a large building.

Kingswood.—The Kingswood Local Board had before them last Wednesday the report of the committee who recently visited Chelmsford to inspect the electric lighting installed there by Messrs. Christie. The chairman stated that to light five miles of road 176 gas lamps would be required, placed 50 yards apart, giving 15 c.p. each, which at £3. 18s. 8d. per lamp would cost £648. 5s. 4d. In addition to this there would be £575 for fixing 176 lamps at £3. 5s. each. The total illuminating power thus given would be 2,640 candles. Under Messrs. Christie's contract the cost for electric lighting would be £621. 10s. This was cheaper than gas, and would give 5,046 c.p., as against 2,640 c.p. by gas, besides which there would be no expense for fixing the lamps. Messrs. Parfitt's tender was for £550, and they proposed to erect six more lamps, with a total of 7,000 indicated c.p. As a matter of fact, there was very little difference between the candle-power of the two tenders, as Messrs. Parfitt allowed for a greater depreciation in illuminating power. It was unanimously resolved to light the district by electricity, and Messrs. Parfitt's tender of £550 was accepted.

Electric Railways.—The following interesting bits are given in Mr. F. Brown's report to the Walsall Corporation. Mr. F. Sprague stated to him that there had not been a single fatal accident from current used on electric railways. At St Paul's, Minneapolis, he found 1,200-h.p. engines driving 12 dynamos, providing current for 135 motor cars, running on 46 miles of double track. The boilers are Babcock and Wilcox, fired by oil at two cents a gallon. The electric cars have run the ordinary steam railway off the road, giving better service at half cost. At Cleveland he found a car passed every six seconds, or about 11 a minute, all well loaded. At Buffalo they have 80 miles at work and 50 more are going down, with a total of 300 cars. At Pittsburgh the Pleasant Valley Company have 780 h.p. at work. The Perrysville line is one of the most difficult in America, being all uphill, a gradient of 12½ per cent., or one in eight, and curves all the way of short radius. The car travelled well at six to eight miles an hour, starting on the curves and without jerks. At moment of starting each car took about 80 h.p. He learnt that in every lawsuit decision about earth circuits the decision had gone with the tramway company.

Illuminating Efficiency of Lamps.—M. A. Witz has communicated to the French Académie des Sciences the result of his researches upon the illuminating efficiency of some of the ordinary forms of lighting apparatus. The following comparative table is obtained :

Source.	Expenditure.	Intensity.		Calories.	
		Carcel.	Candle.	Per carcel-hour.	Per candle-hour.
"L'Etoile" candle...	10·5 gr. pr. hr.	1/6·5	1·4	716	79·5
"Bengel" gas burner	105 litres ,,	1	9	567	63
Recuperative	35 ,, ,,	1	9	189	21
Incandescent electric lamp	3·5 watts per candle	1/6·5	1·4	20	2·22
Arc lamp	·5 ,, ,,	1	9	4	·44

The best absolute efficiency is, of course, that of the arc lamp.

It is more economical to burn gas on an engine for the production of electric light than to use it direct in gas burners, M. Witz concludes. He has substituted 16 arcs and 71 16-c.p. incandescents for six large double recuperative gas lamps, 91 ordinary jets, and 19 batswing burners. Exact measurement showed this electric light to give 15 per cent. more light than the gas lamps for the gas ; and the engine driving the dynamo consumed only 21,500 litres of gas against 26,000 litres per hour of the gas lamps.

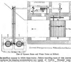
Austrian Companies.—Last week the electrical companies in Vienna published for the first time, says the Vienna correspondent of *Industries*, their reports on the progress of business during the past year. The Vienna Electricity Company, which employs the machinery of Messrs. Siemens and Halske, though it has been working for a year and a half, is not yet in a condition to pay a dividend. There is, however, no deficit, and £23,440 was carried forward to next year's account. The International Electricity Company, which employs Messrs. Ganz and Co.'s machinery, has paid interest out of capital at the rate of 5 per cent. on its capital of £281,250. As the company has spent £168,000 on its Vienna central station, whose cable system is 22 miles in length, and on its central station at Fiume, this rate of interest was much too high. The first balance-sheet of the company consequently shows a deficit of £4,213. On the whole, these companies have done a fairly satisfactory business during the past year. On the Stock Exchange, however, electrical companies have lost credit to some extent, and the Anglo-Austrian Bank has been obliged on this account to postpone the intended issue of shares of the Budapest Electrical Railway. The Prague Electrical Tramway, worked on the system of Herr Krizik, who is the inventor of the well-known Pilsen arc lamp, has been completed, and the preliminary trials of the tramway took place on the 8th inst.

York.—An adjourned meeting of the York City Council was held on Tuesday to consider the electric lighting of the York Law Courts. Alderman Agar moved the adoption of the report of the Municipal Offices Committee, who recommended that the courts of justice, police stations, etc., in Clifford-street, be lighted by electricity, and that the tender of Messrs. Benham and Sons, London, at the sum of £552. 11s., according to specifications submitted by Mr. Sydney Hargraves, electrical engineer, New Bridge-street, London, be accepted, and that Mr. Hargraves be appointed electrical engineer in connection with the wiring of the building, his remuneration to be 35 guineas, to include all charges for revising specifications and plans, reporting on estimates, superintending the wiring, testing and passing the same on completion, and all travelling and incidental expenses. Mr. Mansfield moved as an amendment that the report be referred back to the committee, and Mr. Tripp, in seconding the amendment, complained that the committee had come before the Council with a report recommending electricity when they were not prepared to say whether gas or electricity was the cheapest. Mr. Dodsworth said it was intended by the committee that the plant for lighting the public building should be part of the system for lighting the whole city. Mr. Dickenson thought they would do well to see whether they could themselves successfully carry out the electric lighting of their building. Mr. Mann also moved another amendment, to adopt the report of the committee, and providing also that the police station and fire brigade buildings be lighted with gas, as well as having the electric wire laid on. The amendment was negatived, and the report was adopted.

Safety in Theatres.—We have received from Mr. S. Wilkins, Mansion House-chambers, E.C., a small pamphlet (1s.) by M. Réné Résuche, upon "Crushes and Crowds in Theatres in Cases of Fire or Fright," describing a method which the inventor is seeking to introduce for the better safety of theatres. M. Résuche gives some interesting and suggestive figures both of the numerous fires, amounting to 32 in 1889, and 50 in 1890, in theatres in various parts of the world, together with a table of the total receipts from the theatres of Paris, which goes to show that although there has been a steady rise in receipts (barring the war years) from 1848 to 1884, yet in 1885 accounts were everywhere current of several very disastrous fires, and since then, even during the exhibition year, the receipts have been going down, till there is now a deficit of nearly three-quarters of a million sterling from the calculated average. This is almost entirely due, he thinks, to the fear of fire, and he urges theatre proprietors to make such arrangements as shall ensure absolute safety and ease of exit. He has constructed models in which movable doors or walls of double iron plates filled in with cork or other material are built at suitable places in the outside walls. These either drop down like shutters, giving exit to outside balconies, or, in another model, fall outward like drawbridges, themselves forming a balcony. In case of panic these are all loosed simultaneously by electric or pneumatic contact, and the public find everywhere around them exits to the outside staircases. Panic would thus be avoided, and safety could be assured without the necessity for entire reconstruction of the whole premises, as now seems the only alternatvie. The pamphlet is well worthy of study by those associated with theatre working, and M. Résuche adduces very favourable comments from the Paris papers.

CARLOW.

An invitation from Messrs. J. E. H. Gordon and Co. to be present at what may be termed the inauguration of the electric lighting system at Carlow on Monday, July 13th, directed our steps to the mail leaving Euston at 8.30 on July 12th. Travellers by the L. and N. W. R. are fully acquainted with the excellent manner in which these trains are run. For a moderate fee sleeping accommodation can be had, and one half the physical inconvenience of travel avoided. No less admirable is the boat service from Holyhead to Kingstown. The train arrived punctually at Holyhead, and a few minutes only was needed to see the travellers in their berths, and the boat well on its journey to Kingstown. A quick passage over a sea as smooth as a millpond, a rush to the mail train awaiting the arrival of the boat, a short speedy ride, and we reach Dublin. No time, however, must be lost, and a rush means a jaunting-car to get across the city to the other station and to breakfast, the fourth member of the party following a few minutes later. Dublin is not yet safe, and there is no difficulty in getting across. After breakfast we leave for Carlow, which town is reached about 11 o'clock. There is no rest for the representatives of newspapers when on the warpath—that is, when collecting information—hence, within a short half hour of our arrival at Carlow, the party, reinforced by others previously in the town, are found in a roomy boat belonging to the Carlow Boat Club, with a willing horse upon the towpath, starting for a five-mile trip on the waters of the Barrow to Milford, where in a disused corn mill the generating station will be found.



Plan of Dynamo Room and Water Power at Milford.

Before recording more of this journey, it will be well to speak of Carlow. Situated some 56 miles south of Dublin, at the confluence of the Burren and the Barrow, in the midst of a purely agricultural district, it is scarcely the type of town one would foretell as taking the lead in introducing a new illuminant. But in Carlow gas is dear and not of the highest quality, and the gas management has not conciliated the Town Commissioners, so that lately the public lighting has been by means of oil lamps. Here, then, was a fine opening for the electrical engineer, and, while in Ireland, through the proposed Dublin installation, Mr. J. E. H. Gordon was made acquainted with the position of Carlow and the aspirations of the Commissioners. No time was lost. A temporary installation was put up, proof positive given as to the efficacy of the electric light, terms offered and accepted,

Dynamo Room at Milford.

and the permanent installation commenced. From one point of view, however, it seems somewhat natural that Carlow should take the lead among Irish towns. If we mistake not, Prof. Tyndall, whose name stands in the front rank of scientific worthies of the nineteenth century, first saw the light "just a stone's throw away from Carlow's environs, in her twin borough—old Leighlin," and will be one of the first to recognise the suitability of electricity to assist in utilising the waste water power of the district. According to Mr. Brophy, in his "Carlow Past and Present," the town ought to be termed the "Athens of Leinster," because "it has more the appearance of a city than of an ordinary Irish country town"; its streets are not straggling and irregular; the leading streets converge from four different points on the small centre, the public buildings assume classic styles of architecture, and so on—good reasons to an Irish author, but, like many other statements, hardly convincing. We must admit, however, that the streets are fairly favourable to electric lighting, much more so, indeed, than is the case in many old and in not a few modern towns. Again, the town is fairly compact, an advantage not to be despised when the cost of mains is considered. Returning now to our visit. Given a warm, sunny day, pleasant companions, pretty scenery, and what is more enjoyable than a river journey? One feature in connection with the Barrow was noticeable. There was absolutely no other traffic upon its waters, and weeds were rapidly blocking the stream—thanks to a strike in Dublin, whereby those who usually worked the barges, and those who cleared the stream, were idly standing at the bridge, or to be found under worse conditions elsewhere. Arriving

Oil Insulators for carrying Line and Return.

at Milford, the dynamo-room, in the old mill belonging to Major Alexander, was visited. Here is an Elwell-Parker 50-kilowatt alternator with its exciter, driven by belts from a shaft driven by the huge waterwheel of the old mill. The waterwheel is about 16ft. diameter by 20ft. in length, and under present conditions all the power required can be easily obtained, but in flood time the tail rises till the head of water available is only about 5ft., so arrangements are rapidly approaching completion, when a couple of turbines will be available, and these, together with the waterwheel, which could still be used, would supply some 200 h.p. We illustrate the plan of the dynamo-room, which is fitted with the usual switchboard and measuring apparatus, with a transformer to run the lights required in the works. From the switchboard the mains run to an upper floor, leaving the mill high up, are carried across the river, and run, 30ft. high, on poles along the towpath of the Barrow river, the use of which has been granted at a nominal rent by the Barrow Navigation Company. Fowler-Waring cables are used, and, to make doubly sure, both line and return are carried on Johnson-Phillips oil insulators. The cables fulfil the Board of Trade requirements, which many people think too stringent. The current is generated at 2,000 volts, and transformed down to 50 volts for use. The loss in transmission is now found to be about 1½ per cent., but the calculations have been made to allow of a loss of 10 per cent. when the whole of the public and private lighting is in full swing. The cables are, as we say, brought overhead into a small switchhouse in the centre of the town, where the controlling apparatus for the town lighting is situated, and from whence the circuits can be tested. The distributing cables are installed over about five miles of streets, and are carried on posts set up at the edge of the footpaths, and some of the lamps higher than the others carry the arc lamps. The lamps, in fact, are nearly 20ft. above the street level. They are of the Brockie-Pell type, some fitted with globes, and some with lanterns. Those of the lantern shape seem to find most favour.

The public lighting of the streets has hitherto been carried out by 100 oil lamps of 16 c.p. each, and costing the Town Commissioners £504 per year for a total light of 1,000 c.p. It is now carried out by 13 arc lamps of 1,000 c.p. each, and 40 incandescents of 16 c.p. each, giving a total light of 26,640 c.p., or 20 times the former amount, and for this the Commissioners pay £170 a year.

The present plant provides, in addition to the public lighting, for about 1,200 incandescent lamps in shops and private houses; and these are charged at a fixed rate per annum, calculated to be about 5 per cent. less than the customer's former gas bill.

The transformers which transform the current from the high-pressure form, necessary for carrying it to a distance, to the low pressure of 50 volts at which it is utilised, are fixed upon conveniently selected posts at intervals through the town. No transformer is in any building or

Street Lamppost, carrying Transformer.

private property, or in any way within reach of the public. This is an important element of safety.

The low-pressure system of mains consists of bare copper ropes or strands carried on porcelain insulators, and these are fixed partly on the same posts that carry the high-pressure wires, and partly on the fronts of the houses.

Messrs. Gordon and Co. contend that in the ordinary system of placing transformers it is not profitable to supply a customer unless he will take 15 or 20 lamps, but by the system introduced into Carlow the small customer using one, two, or three lights is, per rate, as good a customer as anybody else, and there seems to be much truth in this contention. We trust that experience will go to prove that many private residents will install a few lights when only a few are really required, so that the summation of these installations will lead to demand to the full capacity of the works.

This point is absolutely essential if electricity is ever to cease to be a luxury of the rich and to become the poor man's light.

Messrs. Gordon claim that they have solved the question, and have brought the light within the reach of anyone who is able to afford gas.

The machinery was started for the first time a few minutes after midnight on Wednesday, June 24 and has run without a hitch or difficulty from the moment of starting.

Messrs. Gordon's engineer-in-charge, Mr. Meredith (son of Mr. George Meredith, the well-known novelist), together with an English foreman, has carried out the work entirely by local labour. The whole of the erection of poles, placing of machinery, wiring of houses, etc., has been done by the ordinary labourers of the district, of whom between 40 and 50 have been employed ever since the work was commenced in December last.

We have in a previous issue referred to the inaugural banquet, and it only remains to add that the various deputations seemed highly pleased with the installation, and went away with the view to use their best endeavours to get the light introduced into the various towns represented by them.

It is difficult to calculate what effect this introduction of a new enterprise may have upon the future political and social development of Ireland.

It is expected that the next town that will be completed by Messrs. Gordon will be Larne, the rising sea port and holiday resort near Belfast, the importance of which is rapidly increasing since the opening of the new Larne and Stranraer mail route, a portion of which will be lighted up on August 1st.

Negotiations are in progress with various other important towns.

NIBLETT'S SOLID ACCUMULATOR.

Of late years many attempts have been made to overcome that inherent weakness of all known electric storage batteries—viz., the warping, buckling, and rapid disintegration of its elements—but so far but little real advance seems to have been made. The want of a really good, inexpensive, mechanically strong cell of high capacity and small weight has been keenly felt by all those who have been associated with electric tramcar work, electric launches, and the almost innumerable other purposes where some form of portable means of storing electrical energy is an essential. The many suggested plans for producing locomotion by means of electricity are just now attracting much attention, and there is every prospect that at no very distant period this branch of electrical engineering will become fully as important as the electric lighting industry is at present. Much may be said in favour of the suggested methods of conveying the electrical energy through overhead conductors, the utilisation of the road rails, or separate insulated high-conductivity conductors as the leads, or the mode of "picking up" the current from underground mains. If, however, a secondary battery can be produced which shall be capable of withstanding the excessive electrical strain incidental to a rapid and irregular rate of discharging, and the mechanically disruptive effect which always seems to attend concussion and jolting, and greatly tells upon all forms of accumulators when used for traction purposes, then the self-contained storage battery system would be found to compare most favourably with any of them, both in point of simplicity and economy.

There can be but little doubt that there is at the present time an enormous field for a cell which will combine large capacity with small weight, and great mechanical solidity. Some little time ago great hopes were entertained that the solidity problem had been solved by the introduction of Dr. Schoop's solid electrolyte. In this country some practical trials have been made with Mr. Barber-Starkey's method of forming solid cells, by substituting for the fluid electrolyte a mixture of wood sawdust and plaster of Paris, which, when set, was moistened with dilute sulphuric acid. In America, the semi-solid batteries of Messrs. Hatch and Wiswell, and Mr. Pumpelly, are said to be doing good work. One great drawback to the employment of a viscous, gelatinous, or solid porous electrolyte resides in the fact that when such substances are interposed between the plates no free circulation of the liquid is possible. In all secondary cells the activity of their elements depends entirely upon chemical action; and as the electrolyte is the medium through which all the necessary reactions take place, it seems highly probable that anything which prevents its free access to the active material, or in any way impedes its circulation, must be detrimental, and lead to loss of efficiency and capacity.

Some new forms of mechanically solid storage cells have recently been devised by Mr. J. T. Niblett, which, in addition to their absolute mechanical solidity, possess the advantages of simplicity of construction, high current capacity, and the property of being able to withstand very high rates of charge and discharge—most important points in storage cells when used for traction or portable purposes.

The new cell in its simplest form is of the Planté plain lead type, but the same method of construction has been applied to the lead, lead-peroxide, lead-zinc, copper-zinc, and many other combinations with the acid or alkaline electrolytes. Each element consists of a highly cellulous mass of material which is capable of absorbing a sufficient quantity of the liquid electrolyte for the due performance of all the possible and necessary chemical reactions. Between each electrode is placed a thin highly porous inert diaphragm, which is found not to materially increase the internal resistance, and which serves to complete the solid character of the cell. In one form an outer metallic containing chamber constitutes one electrode of the couple, and when the cells are joined up to form a battery, an extension of one side of the metal case serves as the electrode of the opposite polarity in the following cell, and so on throughout the series. The cellulous metal which constitutes the elements is prepared by a very simple mechanical process, and it is made electrically active either by the ordinary "forming" operation, by chemical means, or in some cases by the electrolytic deposition of chemically spongy metal. The method of formation will naturally depend upon the nature of the materials which constitute the cell.

Owing to the cellulous nature of these elements the liquid contained within their pores is continually circulating throughout the mass, the slight evolution of gas which is continually occurring both during the charge and discharge being quite sufficient to effect this. Any expansion of the elements occurring in the formation or working, which in other batteries too frequently results in the buckling and disintegration of the plates, and consequent troubles due to short-circuiting, has practically no effect on a battery constructed according to the improved plan, as the whole is solidly contained within a rigid casing, which may be of any strength requisite, and the elements are incapable of displacement. The cellular nature of the electrodes gives them the peculiar property of self-regulating their own internal resistance. If the cell be charged at a too high rate, or when it is on the point of receiving the full complement of its charge, the gas generated tends to drive the electrolyte from the pores of the electrodes, and itself to remain imprisoned therein, thereby greatly increasing the internal resistance. In the same way, as a discharge proceeds the occluded gas re-enters into chemical combination, and allows the liquid to refill the pores, and thereby exposes more active surface. As a means of inserting a hydrometer to test the density of the electrolyte, one or more perforated metal tubes extend throughout the whole depth of the active material, the tubes being of such dimensions as to freely allow of the insertion of the density testing apparatus. By the adoption of Mr. Niblett's plan, any of the ordinary forms of electrodes, whether of the plain lead, the grid, or the compressed slab types, can readily be made up into the solid form without in any way decreasing their current capacity per pound of complete cell, or their general efficiency.

So far the new battery, in its commercial form, has not been put to any prolonged practical trials, but we understand that a battery, consisting of 12 experimental cells were constructed over two years ago, and these have been purposely subjected to much bad and improper treatment, the result being that at the present time the whole of the cells are in excellent condition, and show no signs whatever of deterioration. In the absence of the necessary data as to capacity, efficiency, internal resistance, and the E.M.F.'s of the various combinations, we are, of course, quite unable to say how these cells compare with other well-known forms; but we are assured that experiments have proved that they compare most favourably, both in point of capacity, efficiency, and weight, with any cell yet produced

There can be no doubt that an inexpensive, light, and mechanically solid storage battery is a great desideratum, as there is at the present time a large and increasing demand for portable batteries suitable for such purposes as safety lamps, such as are used in coal mines, petroleum ships, gunpowder mills, gas works, etc. For tramcar propulsion, electric buses, electric launches, and submarine boats, and also for supplying the energy for train, carriage, and other forms of portable electric lighting, a battery capable of withstanding a considerable amount of jolting and rough treatment is much needed. A large number of portable storage batteries are now being employed both in the army and navy, but it is found that the rough treatment they receive seriously tell upon them.

As the battery we have just described seems to possess most of the essentials of a really good portable medium for storing electrical energy, it should be found of much service for the purposes we have enumerated.

In the new cell the whole of the active material is held solidly in position, and cannot move, and it therefore follows that the necessary current collectors may be very light, and in practice it is found that a very high current capacity per pound of complete cell may safely be obtained.

One of the small cells we were shown was constructed for traction purposes, and as an indication of its capabilities the following data is given:

Height	7½in.
Breadth	5in.
Width	5in.
Total weight	11lb. 7oz.
Best rate of charge	5 to 10 amperes.
Best rate of discharge	3 to 6 amperes.
Working current capacity	30 ampere-hours.
Working energy capacity	60 watt-hours.

A small two-cell battery, made for such purposes as safety hand-lamps, etc., was of the following dimensions:

Height	5in.
Breadth	3¾in.
Width	1⅞in.
Total weight	2lb. 10oz.
Best rate of charge	1 to 2 amperes.
Best rate of discharge	0·5 to 1·0 ampere.
Working current capacity	3 ampere-hours.
Working energy capacity	12 watt-hours.

These batteries were of the Planté type, and were simply formed by the ordinary process of charging and reversing. Naturally, as the size and capacity increases the comparative weight decreases. The cells shown to us consisted of a light leaden chamber, forming the negative pole, and these were firmly cemented into a strong wooden outside case Special terminals, which are really elongations of the electrodes, are used. As an example of the mechanical solidity of the Niblett accumulator, the cell exhibited was thrown with some violence several times to the floor without suffering the least injury.

ELECTRIC LIGHTING IN LONDON.

Mr. R. Percy Sellon, M.I.E.E., at the last weekly meeting of the Balloon Society in St. James's Hall, gave an address on the above subject. He gave a sketch of the early history of electric light, and of the first Electric Lighting Act of 1882. Six years later the Electric Lighting Act of 1888 was passed, extending the period of tenure from 21 to 42 years, which, though far from placing electric lighting on the favourable conditions under which gas started, has resulted in an immense development. Nine companies and one local authority are now supplying electricity over the greater part of London, with an aggregate capital of £3,000,000, and already some are paying dividends. The equivalent of half a million lamps of 8 c.p. are now distributed, and additions are being rapidly made; some of the largest have trebled and quadrupled their production within the last 12 months. Mr. Percy Sellon described very fully the contract entered into between the Commissioners of Sewers of the City of London and the Brush and the Laing-Wharton Companies, which constitutes a scheme of an unusually comprehensive character. As regards public lighting, it is the first instance in this country where a public authority has courageously determined to wholly abandon other illuminants in its streets, large and small, in favour of electric lighting. Arc lamps to be placed in the main thoroughfares, and incandescent lamps in the side streets. Then under an extensive scheme of private lighting, current will be supplied to offices, warehouses, and business premises. Upon the question of cost, Mr. Sellon expressed his opinion that the adoption or otherwise of electric light would turn less upon a question of actual cost in pounds, shillings, and pence per quarter than upon a higher standard of comfort among the people. The fact that the City authorities are willing to pay more than twice as much for public lighting by electricity as they have paid previously for gas, points to this conclusion. Mr. Sellon then dealt with the question of danger to life and fire risk, showing that the Board of Trade and fire office rules had rendered these less than than those of gas or oil. At the conclusion of the paper a resolution was carried that it was not desirable that the Legislature should unduly interfere with the development of the electric lighting industry.

EXPERIMENTS WITH ALTERNATE CURRENTS OF VERY HIGH FREQUENCY AND THEIR APPLICATION TO METHODS OF ARTIFICIAL ILLUMINATION.*

BY NIKOLA TESLA.

(Continued from page 64.)

But of all the views on nature, the one which assumes one matter and one force, and a perfect uniformity throughout, is the most scientific and most likely to be true. An infinitesimal world, with the molecules and their atoms spinning and moving in orbits, in much the same manner as celestial bodies, carrying with them and probably spinning with them ether, or in other words, carrying with them static charges, seems to my mind the most probable view, and one which, in a plausible manner, accounts for most of the phenomena observed. The spinning of the molecules and their ether sets up ether tensions or electrostatic strains; the equalisations of ether tensions sets up ether motions or electric currents, and the orbital movements produce the effects of electro and permanent magnetism.

About 15 years ago Prof. Rowland demonstrated a most interesting and important fact—namely, that a static charge carried around produces the effects of an electric current. Leaving out of consideration the precise nature of the mechanism which produces the attraction and repulsion of currents, and conceiving the electrostatically charged molecules in motion, this experimental fact gives us a fair idea of magnetism. We can conceive lines or tubes of force which physically exist, being formed of rows of directed moving molecules; we can see that these lines must be closed; that they must tend to shorten and expand, etc. It likewise explains in a reasonable way the most puzzling phenomenon of all, permanent magnetism, and, in general, has all the beauties of the Ampère theory without possessing the vital defect of the same—namely, the assumption of molecular currents. Without enlarging further upon the subject, I would say that I look upon all electrostatic current and magnetic phenomena as being due to electrostatic molecular forces.

The preceding remarks I have deemed necessary to a full understanding of the subject as it presents itself to my mind.

Of all these phenomena the most important to study are the current phenomena, on account of the already extensive and ever-growing use of currents for industrial purposes. It is now a century since the first practical source of current has been produced, and ever since the phenomena which accompany the flow of currents have been diligently studied, and through the untiring efforts of scientific men the simple laws which govern them have been discovered. But these laws were found to hold good only when the currents are of a steady character. When the currents are rapidly varying in strength, quite different phenomena, often unexpected, present themselves, and quite different laws hold good, which even now have not been determined as fully as is desirable, though through the work, principally of English scientists, enough knowledge has been gained on the subject to enable us to treat simple cases which now present themselves in daily practice.

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* Lecture delivered before the American Institute of Electrical Engineers at Columbia College, New York, May 20.

The phenomena which are peculiar to the changing character of the currents are greatly exalted when the rate of change is increased, hence the study of these currents is considerably facilitated by the employment of properly constructed apparatus. It was with this and other objects in view that I constructed alternate-current machines capable of giving more than two million reversals of current per minute, and to this circumstance it is principally due that I am able to bring to your attention some of the results thus far reached, which I hope will prove to be a step in advance on account of their direct bearing upon one of the most important problems—namely, the production of a practical and efficient source of light.

The study of such rapidly alternating currents is very interesting. Nearly every experiment discloses something new. Many results may, of course, be predicted, but many more are unforeseen. The experimenter makes many interesting observations. For instance, we take a piece of iron and hold it against a magnet. Starting from low alternations and running up higher and higher, we feel the impulses succeed each other faster and faster, get weaker and weaker, and finally disappear. We then observe a continuous pull; the pull, of course, is not continuous; it only appears so to us; our sense of touch is imperfect.

We may next establish an arc between the electrodes and observe as the alternations rise that the note which accompanies alternating arcs gets shriller and shriller, gradually weakens, and finally ceases. The air vibrations, of course, continue, but they are too weak to be perceived; our sense of hearing fails us.

We observe the small physiological effects, the rapid heating of the iron cores and conductors, curious inductive effects, interesting condenser phenomena, and still more interesting light phenomena with a high-tension induction coil. All these experiments and observations would be of the greatest interest to the student, but their description would lead me too far from the principal subject. Partly for this reason, and partly on account of the vastly greater importance, I will confine myself to the description of the light effects produced by these currents.

In the experiments to this end a high-tension induction coil or equivalent apparatus for converting currents of comparatively low into currents of high tension is used.

If you will be sufficiently interested in the results I shall describe as to enter into an experimental study of this subject; if you will be convinced of the truth of the arguments I shall advance, your aim will be to produce high frequencies and high potentials—in other words, powerful electrostatic effects. You will then encounter many difficulties, which, if completely overcome, would allow us to produce truly wonderful results.

First will be met the difficulty of obtaining the required frequencies by means of mechanical apparatus, and, if they be obtained otherwise, obstacles of a different nature will present themselves. Next it will be found difficult to provide the requisite insulation without considerably increasing the size of the apparatus, for the potentials required are high, and owing to the rapidity of the alternations the insulation presents peculiar difficulties. So, for instance, when a gas is present, the discharge may work by the molecular bombardment of the gas and consequent heating, through as much as an inch of the best solid insulating material, such as glass, hard rubber, porcelain, sealing-wax, etc., in fact, through any known insulating substance. The chief requisite in the insulation of the apparatus is, therefore, the exclusion of any gaseous matter.

In general, my experience tends to show that bodies which possess the highest specific inductive capacity, such as glass, afford a rather feeble insulation to others, which, while they are good insulators, have a much smaller specific inductive capacity, such as oils, for instance, the dielectric losses being no doubt greater in the former. The difficulty of insulating, of course, only exists when the potentials are excessively high, for with potentials such as a few thousand volts there is no particular difficulty encountered in conveying currents from a machine giving, say, 20,000 alternations per second, to quite a distance. This number of alternations, however, is by far too small for many purposes, though quite sufficient for some practical applications. This difficulty of insulating is fortunately not a vital drawback; it affects mostly the size of the apparatus, for, when excessively high potentials would be used, the light-giving devices would be located not far from the apparatus, and often they would be quite close to it. As the air-bombardment of the insulated wire is dependent on condenser action, the loss may be reduced to a trifle by using excessively thin wires heavily insulated.

Another difficulty will be encountered in the capacity and self-induction necessarily possessed by the coil. If the coil be large—that is, if it contain a great length of wireit—will be generally unsuited for excessively high frequencies; if it be small, it may be well adapted for such frequencies, but the potential might then not be as high as desired. A good insulator, and preferably one possessing a small specific inductive capacity, would afford a twofold advantage. First, it would enable us to construct a very small coil capable of withstanding enormous differences of potential; and secondly, such a small coil, by reason of its smaller capacity and self-induction, would be capable of a quicker and more vigorous vibration. The problem then of constructing a coil or induction apparatus of any kind possessing the requisite qualities I regard as one of no small importance, and it has occupied me for a considerable time.

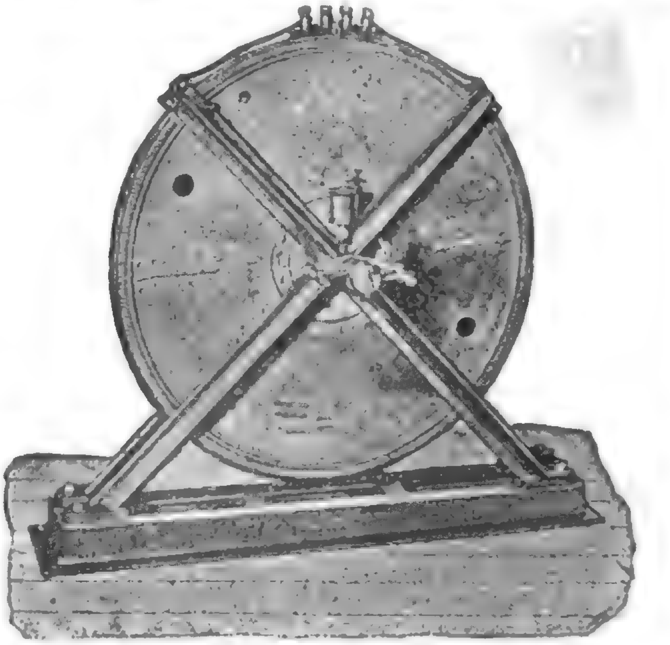

Fig. 1.

The investigator who desires to repeat the experiments which I will describe, with an alternate-current machine, capable of supplying currents of the desired frequency, and an induction coil, will do well to take the primary coil out and mount the secondary in such a manner as to be able to look through the tube upon which the secondary is wound. He will then be able to observe the streams which pass from the primary to the insulating tube, and from their intensity he will know how far he can strain the coil. Without this precaution he is sure to injure the insulation. This arrangement permits, however, an easy exchange of the primaries, which is desirable in these experiments.

The selection of the type of machine best suited for the purpose must be left to the judgment of the experimenter. There are here illustrated three distinct types of machines, which, besides others, I have used in my experiments.

Fig. 1 represents the machine used in my experiments before this institute. The field magnet consists of a ring of wrought iron with 384 pole projections. The armature comprises a steel disc to which is fastened a thin, carefully welded rim of wrought iron. Upon the rim are wound several layers of fine, well annealed iron wire, which, when wound, is passed through shellac. The armature wires are wound around brass pins, wrapped with silk thread. The diameter of the armature wire in this type of machine should not be more than one-sixth of the thickness of the pole projections, else the local action will be considerable.

Fig. 2 represents a larger machine of a different type. The field magnet of this machine consists of two like parts which either enclose an exciting coil, or else are independently wound. Each part has 480 pole projections, the projections of one facing those of the other. The armature consists of a wheel of hard bronze, carrying the conductors which revolve between the projections of the field magnet. To wind the armature conductors, I have found it most convenient to proceed in the following manner: I construct a ring of hard bronze of the required size. This ring and the rim of the wheel are provided with the proper number of pins, and both fastened upon a plate. The armature conductors being wound, the pins are cut off and the ends of the conductors fastened by two rings which screw to the bronze ring and the rim of the wheel respectively. The whole may then be taken off and forms a solid structure.

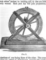

FIG. 2.

FIG. 3.

The conductors in such a type of machine should consist of sheet copper, the thickness of which, of course, depends on the thickness of the pole projections; or else twisted thin wires should be employed.

Fig. 3 is a smaller machine, in many respects similar to the former, only here the armature conductors and the exciting coil are kept stationary, while only a block of wrought iron is revolved.

It would be uselessly lengthening this description were I to dwell more on the details of construction of these machines. Besides, they have been described somewhat more elaborately in the N. Y. *Electrical Engineer* of March 18, 1891.

I deem it well, however, to call the attention of the investigator to two things, the importance of which, though self-evident, he is nevertheless apt to underestimate; namely, to the local action in the conductors, which must be carefully avoided, and to the clearance, which must be small. I may add, that since it is desirable to use very high peripheral speeds, the armature should be of very large diameter in order to avoid impracticable belt speeds. Of the several types of these machines which have been constructed by me, I have found that the type illustrated in Fig. 1 caused me the least trouble in construction, as well as in maintenance, and, on the whole, it has been a good experimental machine.

In operating an induction coil with very rapidly alternating currents, among the first luminous phenomena noticed are naturally those presented by the high-tension discharge. As the number of alternations per second is increased, or as—the number being high—the current through the primary is varied, the discharge gradually changes in appearance. It would be difficult to describe the minor changes which occur, and the conditions which bring them about, but one may note five distinct forms of the discharge.

FIG. 4.

First, one may observe a weak, sensitive discharge in the form of a thin, feeble-coloured thread, Fig. 4. It always occurs when, the number of alternations per second being high, the current through the primary is very small. In spite of the excessively small current, the rate of change is great, and the difference of potential at the terminals of the secondary is therefore considerable, so that the arc is established at great distances; but the quantity of "electricity" set in motion is insignificant, barely sufficient to maintain a thin, threadlike arc. It is excessively sensitive and may be made so to such a degree that the mere act of breathing near the coil will affect it, and unless it is perfectly well protected from currents of air, it wriggles around constantly. Nevertheless, it is in this form excessively persistent, and when the terminals are approached to, say, one-third of the striking distance, it can be blown out only with difficulty. This exceptional persistency, when short, is largely due to the arc being excessively thin; presenting, therefore, a very small surface to the blast. Its great sensitiveness, when very long, is probably due to the motion of the particles of dust suspended in the air.

FIG. 5.

When the current through the primary is increased, the discharge gets broader and stronger, and the effect of the capacity of the coil becomes visible until, finally, under proper conditions, a white flaming arc, Fig. 5, often as thick as one's finger, and striking across the whole coil, is produced. It develops remarkable heat, and may be further characterised by the absence of the high note which accompanies the less powerful discharges. To take a shock from the coil under these conditions would not be advisable, although under different conditions, the potential being much higher, a shock from the coil may be taken with impunity.

(*To be continued.*)

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SUB-STATIONS.

Although many thousands of lamps are in daily use, and although many installations—public and private—are in full working order, it is extremely difficult to obtain accurate information as to cost. On every hand there seems to be the feeling, we have had to pay for our experience, and you must not expect to benefit by that experience. Month after month rolls on, balance-sheets are ransacked for information that is carefully hidden, and the public gets no wiser. Here and there public bodies are compelled to give a certain amount of information, but this is very meagre and far from as full or complete as we should like. Take Bradford, for example. We know the system employed. We know something as to the electric energy consumed. We know also that the loss upon the installation has been and is a constantly decreasing loss, but, as yet, the installation does not pay. In a short time, perhaps, when the extension is carried out, and extra lights are put on, both ends will meet, and then we shall know the approximate number of consumers and lamps required under certain conditions to make a municipal installation pay. So far as estimates are concerned all projected installations will pay, and will pay handsomely. No one, except he be connected with the gas journals, can safely say they won't. Mr. Preece has been taken severely to task because he insists that the electric light is the poor man's light. We have always contended that the comparison of cost directly with gas or oil is fallacious. There are many economies effected by the use of the electric light which ought to be considered. Be that as it may, however, Mr. J. E. H. Gordon has taken up and maintains he has solved another question that brings the electric light within the reach of the poor man. We are not sure that Mr. Gordon can be allowed to claim the idea of sub-stations, but he has undoubtedly paid a great deal of attention to the subject; and if we mistake not, his plans for the lighting of Cambridge, and also for the lighting of Dublin, included the use of sub-stations. Putting aside Mr. Crompton's views for the moment, and admitting the best method of town lighting is by generating at a high pressure at a point where labour and power are cheap, where rent and rates are low, and transmitting under the high pressure to the point where the electric energy is wanted, and there transferring down to the pressure required—is it best to have a transformer in every house, or to have a transformer for a block of houses? The whole question is one of pure calculation, and in the majority of cases undoubtedly the proper plan is to transform for a block of houses. This leads to a network of purely distributing mains, which network can be fed at certain points by the transformers, so that the current density and pressure in the network is the same throughout. Mr. Gordon maintains that it does not pay to put in a transformer for much less than 20 lamps, while numbers of small householders never require more than three or four gas jets, and similarly only require three or four lamps. From a network these small consumers can be supplied as economically as the larger consumers can with their own transformers. Will the small consumers patronise the light? is a question that has yet to be answered. We think they will, and Messrs. Gordon and Co.'s experience at Carlow will be watched with some interest to see if the surmise is correct.

THE LATE WILLOUGHBY SMITH.

It is with deep and sincere regret that we have to record the death of Mr. Willoughby Smith. A short time since we chronicled the death of David Brooks, an American telegraphic pioneer. Now one of our own pioneers has gone, thinning the meagre ranks of those whose exertions and energy made submarine telegraphy practical. Quite recently, too, our late friend completed and issued his monograph on the development of cable work. Before briefly sketching his career we may be permitted to speak of the man as a friend. After all, there is a something which appeals forcibly to older men—casting a glamour upon those good old days when, younger and more vigorous, they were pushing ahead in their career, surrounded by congenial companions, whose faces as time rolls on are seen less and less frequently, till they enter the great unknown. Among a small crowd of young men Willoughby Smith was not the least prominent. His friendship was not given hastily, but when given it was that of a "friend in need." His principle was to speak of men, and act towards them, as he found them, and not from hearsay would he withdraw one atom of the confidence he reposed in his friend. True as steel, gentle, and considerate, though never permitting an imposition, he gradually passed, as we say, into the front rank of those connected with cable work. As long ago as 1848 Willoughby Smith entered the service of the Gutta Percha Company, and soon after this date the Gutta Percha Company commenced experimenting with a view to covering iron or copper wires with guttapercha for telegraphic or other electric purposes. In 1849 they had so far succeeded with these experiments that they undertook to supply 30 miles of copper wire covered with a thick coating of guttapercha, to be laid from Dover to Calais, with a view to practically demonstrating the feasibility of submarine telegraphy. During the years 1849-50 Mr. Smith was busily engaged in the manufacture and laying of this line. The trouble and annoyance caused by the imperfect system of making the joints in the experimental line induced Mr. Smith to give this subject his special attention, and in the cable laid over the same course in the following year (in the manufacture and laying of which he was engaged) he introduced a system of joint making which proved a great success, and in 1855 the present system of joining and insulating the conductor.

From this time onward he was constantly engaged either with cable work or with underground land lines. Early in 1854 the first cable to be laid in the Mediterranean was commenced. Mr. Smith had charge of the electrical department during its manufacture, and assisted Prof. Wheatstone with his experiments on the retardation of signals through this cable, while coiled at the works of Messrs. Glass, Elliott, and Co., East Greenwich. These experiments were made for the purpose of verifying or correcting the results of similar experiments which had been made by Prof. Faraday on lengths of the core of this cable at the Gutta Percha Company's works earlier in the same year. Mr. Smith took charge of the electrical department during the laying of this cable between Spezzia and Corsica, Corsica and Sardinia, and in the following year was similarly employed in the manufacture and laying of a cable between Sardinia and Bona. During the manufacture of this cable Dr. Whitehouse made experiments with it to obtain trustworthy data for giving suitable proportions for the core of an Atlantic cable which was then in contemplation. On Mr. Smith's return from this expedition he remained at home as electrician and manager of the wire department at the Gutta Percha Works, and at once commenced to prepare for the manufacture of 2,500 miles of core for a cable which was to be laid from Ireland to Newfoundland. In 1851, after the manufacture of the single-covered copper wire already referred to as having been laid from Dover to Calais, it was thought advisable to apply the guttapercha in two or more thin, instead of one thick covering, and to ensure adhesion between these separate coverings coal-tar naphtha was employed. But time showed that so strong a solvent of guttapercha was very prejudicial to its durability, and in 1858 Mr. Willoughby Smith invented an insulating and adhesive compound suitable for application between each covering of the guttapercha, instead of the coal-tar naphtha. This compound was soon adopted, and is in general use at the present time. In 1864 the works of Messrs. Glass, Elliot, and Co., at Greenwich, and the Gutta Percha Company, were formed into "The Telegraph Construction and Maintenance Company," Mr. Smith retaining his position at the Gutta Percha Works. In 1865 the late Sir Richard Glass, the then managing director of the Telegraph Construction and Maintenance Company, requested Mr. Smith to accompany the "Great Eastern," and render assistance, if necessary, in the laying of the cable from Ireland to Newfoundland. Early in 1866 Mr. Smith was appointed chief electrician to the Telegraph Construction and Maintenance Company, and in that capacity was engaged on board the "Great Eastern" during the successful laying of the cable from Ireland to Newfoundland, and the recovery and completion of the cable lost the previous year. Mr. Smith's new system was adopted on that occasion. On the completion of the cables, Mr. Smith applied his system to their working, and before he left the station at Heart's Content to return home in the "Great Eastern," he had the pleasure of seeing a speed of 13 words per minute obtained on each cable.

Subsequently, Mr. Willoughby Smith took charge of the French Atlantic cable expedition. The cable was successfully laid, but the strain had been too great, and the chief electrician was for some time incapacitated from work. After his recovery he experimented upon and improved the manufacture of guttapercha for cable work. But is not his life-long work well set forth in his recently published book? and to it our readers should turn to see what progress was made in one industry during a lifetime. Mr. Willoughby Smith was a fairly prolific writer, contributing to periodical literature, and to the *Journal* of the Institution of Telegraph Engineers, of which he was president in 1882-3. It was not till after about 40 years of active service that Mr. Smith severed his connection with cable work.

His remains were interred at the Highgate Cemetery on Wednesday, in the presence of a large number of friends. The Institution in which he had taken so great an interest was represented by Prof. W. Crookes, F.R.S., president; Prof. Cary-Foster, F.R.S., vice-president; and Mr. F. H. Webb, secretary.

CREOSOTING TIMBER.*

BY E. J. SILCOCK, A.M.I.C.E., F.G.S., BOROUGH ENGINEER, KING'S LYNN.

(Concluded from page 55.)

Boulton's process is an improvement in another direction. Having extracted a large portion of the sap in the shape of steam, there is not such a large quantity of albumenoid matter to coagulate, so that the quantity of tar acids may be reduced, and oils of an inferior quality may be used without decreasing the efficiency of the treatment. This is important, as the tar acids are now very largely extracted from the creosote oils for other commercial purposes, and with ordinary London oils the percentage of tar acids is not as high as prudence would dictate if all the sap in young timber is left in. The plant required for Blythe's process is somewhat similar to Bethell's, except that no air pump is provided, and a steam injector replaces the pressure pump.

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* Paper read before the London meeting of the Association of Municipal and County Engineers.

Blythe's process, known as "thermo-carbolisation," differs, however, in principle from Bethell's and Boulton's. The oils in this system are applied first in a gaseous or finely-divided state, and subsequently as a liquid. The process is carried out as follows: The timber is stacked in a closed cylinder, and superheated steam, at a temperature of 800deg F., is supplied to the injector. The injector delivers into the bottom of the cylinder and draws its supply of oils from a tank. There is also a pipe connecting the top of the cylinder with the injector, so arranged that the injector exhausts the gases from the top of the cylinder, and re-delivers them, along with fresh supplies of finely-divided oil, at the bottom of the cylinder. In this manner a continuous circulation of gases is kept up for 30 minutes or longer, the temperature of the gases varying from 80deg. to 90deg. F. at the commencement, to above 212deg. F. The steam is then turned off, and the cylinder and contents allowed to cool. If the timber is required for joinery or building purposes, the process stops at this point; if, on the other hand, the timber is required for underground or hydraulic works the cylinder is connected with the creosote tanks, and oils are pumped in by steam pressure or ordinary pumps, as in Bethell's process. The author has had no practical experience of this system, but it is claimed that it dries, hardens, and protects timber, the oils penetrating the heart as well as the sap wood. The system is used by the Great Northern Railway Company, whose engineer states that the results produced are similar to those obtained by Bethell's process. It is difficult to see by what means the effects claimed are obtained. Circulating steam at a temperature of 90deg. to 212deg. F. around timber cannot, one would imagine, have a very drying effect, and as the boiling points of carbolic acid and naphthalene are 360deg. F. and 422deg. F. respectively, these bodies, to say nothing of the heavier constituents of creosote, cannot be in a gaseous state at all, although they may be in a very finely-divided state, and so penetrate the pores of the timber. Probably the most effective part of the system is the pumping in of creosote in the liquid state, as in the older processes. All timber should be inspected before treatment as it is practically impossible to judge of the quality of the timber afterwards; and a rigid system of inspection should be enforced to see that the provisions of the specification are carried out, for, except in the case of small scantlings treated by Bethell's process, which can be weighed before and after treatment, there is no method of checking the quantity of oils injected, except by an inspector being present during treatment, and himself gauging the quantity of oil absorbed. As far as practicable, timbers of similar scantlings should be treated at the same charge—*e.g.*, 12in. square timbers and 2in. planking should not be treated at the same operation, or the planks will absorb more than their share of oil, and instead of the large timber getting the specified quantity of oil, it will be robbed by the planking. It need hardly be pointed out that all carpentering operations performed on the timber after treatment militate against the success of the process, and, by breaking through the crust of creosoted fibres, points of access for air, water, and micro organisms are made. It is therefore desirable, as far as possible, to prepare the timber before treatment, and such structures as gates, troughs, etc., which can be introduced bodily into the pressure cylinder should be treated after completion. Where this cannot be done all mortises and tenons, and other places where the uncreosoted parts of the timber are exposed, should be paid with coal tar before the joints are made.

Timber which is intended to resist marine insects is, where practicable, better employed in the round state, because the sap wood more readily absorbs the creosote than the heart wood, and this forms an armour against the worm. The author submits for inspection a few specimens of timber creosoted by the different processes, to show the depth to which naphthalene and the heavier oils penetrate. It will be noticed that sap wood absorbs creosote much more readily than heart wood.

No. 1 is a section cut from a red wood post creosoted by the open tank process, the timber having been immersed for about a fortnight.

No. 2 is part of a section of a 12in. by 12in. Memel pile, treated by Bethell's process, with one gallon of oil per cubic foot.

No. 3 is a section of a Memel plank 11in. by 4in., similarly treated.

No. 4 is a section of a 12in. by 3in. red wood plank, creosoted by the same process, but with 7lb. of oil per cubic foot.

No. 5 is a section cut from the centre of a Baltic sleeper, 10in. by 5in., treated by Boulton's process, with 7lb. of oil per cubic foot.

No. 6 is a section of a similar sleeper, treated by the same process, but one gallon of oil per cubic foot has been injected.

No. 7 is a section of a sleeper, treated by Bethell's process, which absorbed creosote at the rate of 23½lb. per cubic foot.

In conclusion, the author submits the following as a standard specification.

The whole of the timber used must be creosoted with coal-tar creosote, which shall be completely fluid at 100deg. F., shall yield 5 per cent. of tar acids, and contain 25 per cent. of constituents which do not distil under 535deg. F. The creosoting must be carried out in the following manner: The timber must be placed in a closed iron cylinder fitted with a dome, an air pump, and a pressure pump, and capable of being heated. As much creosote must be admitted to the cylinder as will nearly fill it; the temperature of the oil must then be raised to over 212deg. F., and the air pump put to work until all moisture in the shape of steam has been exhausted. The cylinder must then be completely filled with creosote, and the pressure pump worked until a pressure of 100lb. per square inch is produced, and the timber has taken up creosote at the rate of one gallon per cubic foot.

THE ELECTRIC TRANSMISSION OF POWER.*

BY GISBERT KAPP.

Lecture II.—Fundamental Principles.

The fundamental principle on which the electric transmission of power depends is that peculiar, and, I might almost say, mysterious interaction between magnets and currents, which we comprise under the name electromagnetic induction; but more particularly two special cases of electromagnetic induction, the one discovered by Oersted and the other by Faraday. Oersted discovered that, under certain conditions, a compass needle is deflected by an electric current, and Faraday discovered that relative motion between a magnet and a closed conductor will, under certain conditions, produce a current of short duration in the conductor. Oersted's effect is a permanent one; the needle remains deflected as long as the current flows. Faraday's effect is transient; the current flows, not as long as the magnet is present, but only during the time that it takes to change the relative position of magnet and closed conductor.

It is clear that, in Oersted's experiment, the movement of the needle is due to the action of a mechanical force between the magnet and the coil. In Faraday's experiment the transient current must be caused by a transient E.M.F., and this, in its turn, is caused by the relative movement between the coil and magnet. The modern method of explaining these things is based on the conception of magnetic lines of force, and the looping of these lines with the wire coil through which the current flows. The whole subject has been so admirably laid before this society in the Cantor Lectures on the Dynamo, which Prof. S. P. Thompson delivered here in 1882, that I need not occupy time by going over the same ground again, but may take it for granted that you are familiar with the lines of force theory. In modern language we may therefore explain the two fundamental phenomena somewhat as follows:

1. The looping of a current with magnetic lines of force sets up a mechanical force between the conductor and magnet (or its equivalent).

2. Relative movement between a magnet (or its equivalent) and a wire coil sets up in the latter an E.M.F.

It follows immediately from these two propositions that looping and movement combined will require the expenditure of power, or yield power, accordingly as the movement is opposed to or in the direction of the mechanical force produced by the looping. In other words, that we can, by these simple means, convert mechanical into electrical power, or electrical nto mechanical power. If we carry out both processes at the ame time—that is, if we combine Faraday's with Oersted's experiment—we require, of course, a pair of wires between the two converting instruments. In Faraday's experiment, if we thrust the steel magnet into the wire coil, we expend mechanical power, which is converted into the electrical power represented by a current flowing under a certain, though in this case very small, potential difference. The power represented by this current is again reconverted in Oersted's experiment into mechanical power, which is used to produce the deflection of the magnet. The total amount of power thus transmitted from one place to another is, of course, exceedingly small, but the same principle, applied on a larger scale, effects the transmission of many horse-powers, and it will be my task to show you how this is done in practice.

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* Cantor lectures delivered before the Society of Arts.

Before entering upon this subject I must explain an expression used, in stating the fundamental principles on which the electric transmission of power is based. I said that we require a coil and a magnet "or its equivalent." The equivalent of a magnet is, as you know, a coil through which a current flows, and the experiments ought therefore also to succeed if instead of the magnet we use such a coil. In practical work we use neither a steel magnet nor a coil alone, but a combination of a coil with an iron core constituting what is known as an electromagnet.

You know that according to our modern conception of magnetic fields, there emanates from each pole of a magnet a certain flow of lines of force; and when we thrust a magnet into a coil we cause the individual wires of the coil to cut through the lines of force. The quicker the movement—that is to say, the more lines of force are cut by each wire in unit time—the greater is the E.M.F. produced; and the more wires are contained in the coil the greater is the E.M.F. produced, since the E.M.F. impulses of the different convolutions are added. It is also easily seen by experiment that the stronger the magnet the greater will be the E.M.F.; so that we find that the E.M.F. is proportional to the product of strength of field, speed of cutting, and length of conductor. Denoting these quantities respectively by H, v, and l, the E.M.F. produced is in C.G.S. units $H\,v\,l$, and remembering that a hundred million C.G.S. units of E.M.F. are equivalent to one volt, we have the E.M.F. in volts given by the expression

$$\text{Volts} = H\,v\,l\,10^{-8},$$

In this formula the strength of field is given in lines per square centimetre and speed and length are given in centimetres.

The mechanical force experienced by a conductor in the neighbourhood of a magnet pole is, according to our modern views, due to the fact that the conductor is laid across the lines of force emanating from the magnet pole. The force in dynes is given by the product, $H\,c\,l$, c being the current. Since there are 981,000 dynes required to represent the force of one kilogramme, and since the C.G.S. unit of current is 10 amperes, we have the force produced by a current of c amperes—

$$\text{Kilogrammes} = \frac{H\,c\,l}{9{,}810{,}000}$$

These are the two fundamental equations required in the design of plant for the electric transmission of power. Now let us see what is the most simple kind of plant we could possibly employ. At the generating station we require a conductor cutting lines of force; this conductor must be joined by wires with a similar conductor at the receiving station. The second conductor is also laid across lines of force, so that when a current passes it will be acted upon by a mechanical force displacing it parallel to itself and doing work. The arrangement here described is shown in Fig. 1, where the lines R represent fixed, horizontal, parallel rails, across which are laid sliding rails or sliders, S_1 S_2. Imagine the magnetic lines of force passing vertically between the fixed rails, then, if we displace the slider, S_1, an E.M.F. will be set up in it, causing a current to flow through the connecting wires, W, and the slider, S_2, at the receiving station. The slider, S_2, is supposed to be laid across lines of force, and will, therefore, be acted upon by a mechanical force. Thus, power may be electrically transmitted from the slider S_1 to the slider S_2. It will immediately occur to you that the experiment I have here illustrated could easily be tried by means of any railway. The fixed conductors and connecting wires would be the rails; the generating slider would be a crowbar thrown across them, and hauled along by a train; and the lines of force would be supplied by the vertical component of terrestrial magnetism. At another part of the railway—possibly miles away—another crowbar thrown across the rails should then be set in motion by the current passing through it. Theoretically, such an arrangement represents correctly enough the electric transmission of power; but I need hardly tell you that it would not work in practice. If you apply the E.M.F. formula I have given to this case, you will find that even if the slider is hauled along at the speed of an express train, there will only be generated about the one-thousandth part of a volt, the reason being that the magnetic field provided for us by nature is so extremely weak. If we could apply an artificial magnetic field of the strength generally employed in dynamo machines—that is, about 10,000 times as strong as the vertical component of terrestrial magnetism—then we could get about 10 volts in our slider. Now, it is obvious that we cannot spread so strong a field over miles of railway, and we must therefore alter our arrangement. This may be done as indicated in Fig. 2, where one of the rails has been replaced by a centre contact, and the other by a circular conductor. The slider, instead of being moved parallel to itself, must now revolve round the centre contact, which can easily be done by a belt and pulley. We have thus arrived at what is known as a non-polar dynamo. But even this arrangement, although very much better than the progressive slider, is not of practical value for power transmission, because the E.M.F. of non-polar dynamos is still too low. It is only a few volts, whereas we require hundreds, or even thousands, of volts to carry the current to any distance. The obvious remedy is to use a large number of revolving sliders, so connected that the E.M.F. generated in each shall be added; in other words, instead of a non-polar dynamo, we must use an ordinary continuous-current dynamo, wound for high E.M.F. This arrangement is shown in Fig. 3, where G_1 is the generator and G_2 the motor or receiving dynamo. If you connect their brushes, as show in the diagram, and rotate the armature of the generator, a current flows through it, the line wire, W, and through the armature of the motor, and exerts upon the latter a mechanical force, tending to produce rotation and give off mechanical power. I am able to show you this experimentally, by means of two dynamos connected, as shown in Fig. 3.

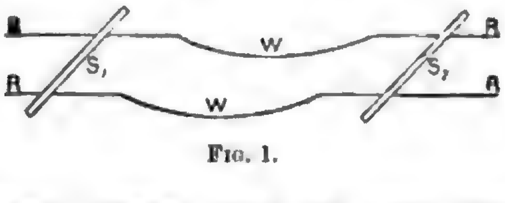

Fig. 1.

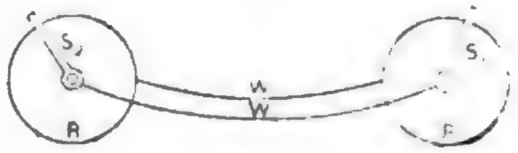

Fig. 2.

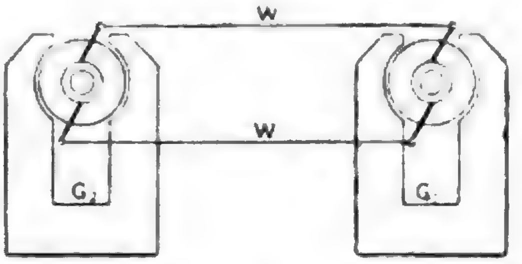

Fig. 3.

The Machines Employed in Power Transmission.

This experiment has shown how power may be transmitted electrically. Let us now consider somewhat more in detail the different parts of the transmitting plant. At one end of the line of transmission we have the generating dynamo, at the other we have the motor dynamo, and then we have the line itself, consisting of two wires insulated from each other and from earth. You will readily see that although for the convenience of experimental illustration I have placed the generator and motor close together, this proximity was not an essential condition of the experiment. The motor might have been placed in another room, or in a different part of London, and still the experiment would have succeeded, provided I had used sufficiently stout and well-insulated connecting wires. But then you could not have had ocular demonstration of the fact that movement of the generator armature is closely followed by a corresponding movement of the motor armature.

A full treatment of my subject would of course include a complete investigation of the dynamo, but this I shall not attempt. In the first place there is no time for it, and in the second place it is hardly necessary, since you are all more or less acquainted with these machines. I shall, therefore, not occupy time by giving mathematical proofs for the few formulæ

I shall have to use, but assume that they are familiar to you. They are as follows :

$$\text{Volts} \ldots\ldots\ldots\ldots = \mathrm{H}\,v\,l\,10^{-8}$$

$$\text{Kilogrammes} = \frac{\mathrm{H}\,c\,l}{9{,}810{,}000}$$

C Total current through armature ; c, current through single armature conductor.

e_a E.M.F. in armature in volts.

τ Number of active conductors counted all round armature.

p Number of pairs of poles ($p = 1$ in a two-pole machine).

n Speed in revolutions per minute.

F Total induction in C.G.S. lines.

Z Total induction in English lines.

$$\text{Electromotive force.}\left\{\begin{array}{l} \left.\begin{array}{l} e_a = \mathrm{F}\,\tau\,\frac{n}{60}10^{-8} \\ e_a = \mathrm{Z}\,\tau\,n\,10^{-8} \end{array}\right\}\text{for two-pole machines.} \\ \left.\begin{array}{l} e_a = p\,\mathrm{F}\,\tau\,\frac{n}{60}10^{-8} \\ e_a = p\,\mathrm{Z}\,\tau\,n\,10^{-8} \end{array}\right\}\text{for multipolar machines with series-wound armature.} \end{array}\right.$$

$$\text{Torque} \ldots\ldots\ldots \left\{\begin{array}{l} \left.\begin{array}{l} \text{Kilogramme-metres} = 1{\cdot}615\,\mathrm{F}\,\tau\,\mathrm{C}\,10^{-10} \\ \text{Foot-pounds} \ldots\ldots = 7{\cdot}05\,\mathrm{Z}\,\tau\,\mathrm{C}\,10^{-8} \end{array}\right\}\text{for two-pole machines.} \\ \left.\begin{array}{l} \text{Kilogramme-metres} = 3{\cdot}23\,\mathrm{F}\,\tau\,c\,p\,10^{-10} \\ \text{Foot-pounds} \ldots\ldots\ldots = 14{\cdot}10\,\mathrm{Z}\,\tau\,c\,p\,10^{-8} \end{array}\right\}\text{for multipolar machines.} \end{array}\right.$$

In analysing these formulæ you will observe a curious parallelism. The symbols for field strength and total number of active armature wires occur in either group, but the current occurs only in the group giving torque, or mechanical turning effort, and the speed occurs only in the group giving E.M.F. Now, if you multiply any of the torque formulæ with the speed, you get on the left mechanical power, and on the right the product of E.M.F., multiplied with current and a constant, or, in other words, electrical power ; by working this out in figures you will find that mechanical energy expressed in horse-power is equal to watts divided by 746, the well-known equation for converting mechanical into electric power.

The formulæ are equally applicable to cylinder armatures wound Gramme fashion and to drum armatures, provided we count not turns of wire but active conductors over the whole circumference of the armature. As regards two-pole machines, the formulæ are the same as found in every text-book on dynamos, but as regards multipolar machines a little explanation is required, both as to the winding and as to the advantage or otherwise of using more than one pair of poles. To make the explanation clear I must refer for a moment to the ordinary method of drum winding for two-pole armatures. When such a winding is illustrated in a text-book, the author takes care to show only very few conductors, for the simple reason that the diagram would be one unintelligible maze of lines if it were drawn so as to represent an armature as really made. To get over this difficulty I employ, instead of a diagram, a tabular statement of the winding such as you see on the wall. This particular table represents the winding of a drum armature having 100 active conductors.

The figures at the top of the vertical columns indicate the direction of winding, supposing the winder looks at the armature end on. The letter D signifies a wire wound down or away from him ; and the letter U, a wire wound up or towards him. The letters F and B, placed between the others, denote the front and back connections respectively. In modern machines these connections are not made of flexible wire, but are separate pieces, specially made to shape, and are generally of larger section than the conductor, so as to reduce the resistance of the armature as much as possible. One form of connector is on the table, both in pieces and built up. By referring to the winding-table, you will see that every wire is numbered ; and thus we can see at a glance how the ends of each wire are connected. The table on the wall refers to a two-pole machine ; that on the slip in your hands to an eight-pole machine, wound so as to obtain the E.M.F. of the four pairs of poles in series. The printed table, giving the eight-pole winding, is almost self-explanatory ; but to assist you in understanding the winding of these multipolar machines generally, I had this model prepared, showing a few of the conductors of a six-pole armature. This method of winding has been invented by Messrs. Scott and Paris : patents 4,683 and 6,261, of 1874. There are no internal cross connections, the ends of the conductors being joined simply by connecting segments of the kind I have just shown you, but with this difference, that each segment, instead of embracing half a circle, embraces only one-sixth of a circle. The winding goes in zig-zag, so to speak, round the armature, returning to the second wire in front or behind the previous starting point. There are thus only two brushes required. The winding-tables show, also, very clearly how the E.M.F. increases from wire to wire, and that the greatest difference of potential occurs between neighbouring wires at the diameter of commutation. The difference of potential between neighbouring connector segments is, however, limited to the E.M.F. due to the two conductors. The winding is used for machines intended to give high-pressure currents, such as are required in power transmission. When low pressure and large currents are required, the winding is altered, so as to form overlapping loops on the armature, and for intermediate E.M.F.'s a combination of both methods can be used. But as these windings have no immediate importance for power transmission, I shall not detain you with a description of them.

Drum Winding.

F		B		F		B		F		B		F		B		F		B		F
	D		U		D		U		D		U		D		U		D		U	
	100		49	−	98		47		96		45		94		43		92		41	
	90		39		88		37		86		35		84		33		82		31	
	80		29		78		27		76		25		74		23		72		21	
	70		19		68		17		66		15		64		13		62		11	
	60		9		58		7		56		5		54		3		52		1	
	50		99	+	48		97		46		95		44		93		42		91	
	40		89		38		87		36		85		34		83		32		81	
	30		79		28		77		26		75		24		73		22		71	
	20		69		18		67		16		65		14		63		12		61	
	10		59		8		57		6		55		4		53		2		51	
	100		49	-	98															

Table of Winding for 8-pole Drum Armature ; 202 Conductors ; Series Winding ; Brushes (±) 135deg. apart.

F		B		F		B		F		B		F		B		F
	D		U		D		U		D		U		D		U	
	202		25		50		75		100		125		150		175	
	200		23		48		73		98		123		148		173	
	198		21		46		71		96		121		146		171	
	196		19	–	44		69		94		119		144		169	
	194		17		42		67		92		117		142		167	
	192		15		40		65		90		115		140		165	
	190		13		38		63		88		113		138		163	
	188		11		36		61		86		111		136		161	
	186		9		34		59		84		109		134		159	
	184		7		32		57		82		107		132		157	
	182		5		30		55		80		105		130		155	
	180		3		28		53		78		103		128		153	
	178		1		26		51		76		101		126		151	
	176		201		24		49		74		99		124		149	
	174		199		22		47		72		97		122		147	
	172		197		20		45		70		95	+	120		145	
	170		195		18		43		68		93		118		143	
	168		193		16		41		66		91		116		141	
	166		191		14		39		64		89		114		139	
	164		189		12		37		62		87		112		137	
	162		187		10		35		60		85		110		135	
	160		185		8		33		58		83		108		133	
	158		183		6		31		56		81		106		131	
	156		181		4		29		54		79		104		129	
	154		179		2		27		52		77		102		127	
	152		177		202											

Now as to the advantage of multipolar machines, such as the one which I illustrated on the screen. The field magnets are arranged perfectly symmetrical round the armature ; and thus the one-sided magnetic pull, consequent upon the employment of a single pair of horseshoe magnets, is avoided. There is very little magnetic leakage, the machine being what is known as iron-clad ; and, as I have already shown, the E.M.F. is equivalent to that of several smaller machines, coupled in series. The internal diameter of the armature is very large, affording plenty of space for the ingress and egress of air, and the weight of the machine is less than that of an equivalent two-pole machine. The most important advantage, however, is the small armature reaction. Experience with large two-pole machines has shown that there is a limit to the size above which such machines are satisfactory. This limit depends, of course, on the speed and voltage, as well as on the output ; but, roughly speaking, we may take it that, for moderately high voltage, and an output above 100 h.p., the multipolar machine is preferable ; and we find, accordingly, that for the transmission of large powers multipolar machines are, as a rule, employed.

I have hitherto not made any distinction between motors and generators, because the difference between them is almost negligible. There are certain secondary effects which may be a little greater in one machine than in the other; but these are of so little importance that it will not be worth while to devote any time to their consideration. As a rule a good generator makes a good motor. All we require to do is to set the brushes a little forward of the neutral line in the former, and a little back from that line in the latter. Now let us see what it is we must naturally aim at in putting up a transmission plant.

At the generating end of the line we want as high an E.M.F., as we can get, because a high E.M.F. means large power and small percentage loss due to line resistance. At the motor end we want as large a torque or statical effort as possible, combined with a certain speed. But a glance at the formulæ will show that it is impossible to get speed without also getting E.M.F., which, in the case of the motor, must oppose the current, and thus the current actually flowing through the motor is that due to the difference between the E.M.F. of the generator and the counter E.M.F. of the motor. This difference divided by the total resistance of the circuit gives the current.

The electrical power developed in the generator is the product of this current, and the E.M.F. in its armature. The electrical power converted by the motor is the product of the same current and the counter E.M.F. of its armature. It therefore follows that the electrical efficiency of the whole system is given by the ratio between the generator and motor E.M.F. The more nearly alike these two are—that is to say, the less E.M.F. lost in resistance—the greater will be the electric efficiency. Now the smaller the current the less E.M.F. is lost in resistance, but to get power with a small current we must work at high pressure, and we thus find that from the point of view of electrical efficiency only, the higher the voltage the better.

There are, however, other things to be considered besides electrical efficiency, and if we take due account of these we find that for every case there is one particular voltage at which it is best to work.

Upon this subject I shall enter presently, but before doing so I must place before you some points in connection with the regulation of speed and power in transmission plants. Unless we can control the speed and regulate the power given out at the receiving end of the line, the most perfect motor or the most efficient system is useless. Fortunately, however, electricity is not only a powerful transmitting agent, but also one that can be easily controlled, and my next task is to show you how this control is effected.

What we generally desire to get in practice is a constant speed of the motor, whatever may be the mechanical power taken out of it at any moment. This condition is the same as that required from a good steam engine or other well-governed prime mover. The construction of the motor to comply with this requirement depends, of course, on the condition of supply.

We can imagine a large variety of cases, but from a practical point of view I need only consider two—namely, supply at constant pressure such as we get, or ought to get, from mains connected with a central electric light station, and supply of current at constant or variable pressure from a generator erected specially for the purpose, the regulation of current and pressure being automatic. The latter case is that more particularly met with in long-distance transmission of large powers, the former is a case referring rather to the distribution of small parcels of power over short distances from a central station. I will take this first.

We have, then, these supply conditions—pressure at the terminals of the motor constant, current variable, according to the call for power. Let, in the diagram Fig. 4, the curve F represent the characteristic of magnetisation of an electromotor, that is, a curve obtained by plotting ampere-turns of exciting power on the horizontal and total field strength (denoted in the formulæ by F or Z) on the vertical. If the motor is series wound you see that the larger the current the stronger will be its field, and by referring to the E.M.F. formula you will find that if the speed is to remain constant the counter E.M.F. must increase in the same ratio as the field strength increases. But the counter E.M.F. must under all circumstances be smaller than the supply E.M.F. by just the amount required to overcome the resistance of the circuit through the motor, and this difference is of course proportional to the current. To satisfy the supply condition the counter E.M.F. of the motor ought to slightly decrease as the load and with it the current increases, then the speed will keep constant. But this is exactly the opposite of what the motor requires. Say the machine is running at a certain speed, and giving out a certain amount of mechanical power. Now increase the load. The immediate consequence will be that the speed is slightly decreased, the counter E.M.F. is slightly decreased, and the current is increased. This will immediately strengthen the field, and thus raise the counter E.M.F. again; this will check the current, produce a further drop in speed, and so the reaction will go on until a new stable condition of working is reached at a larger current and lower speed. If we take the load off, the same reaction takes place, only in the opposite sense, and the speed may become dangerously high. What I have here described happens, of course, only if the machine is worked on the rising part of the E.M.F. characteristic E, the part which we would naturally select for economical working. If we over-excite the field magnets—that is, if we employ a great deal more field wire than necessary—then we can work the machine on the drooping part of the characteristic shown by a dotted line in the diagram and obtain approximately constant speed between certain limits, but the machine will still be liable to race as soon as we throw the load off completely. We thus find that a series-wound motor is certainly not suitable for our purpose.

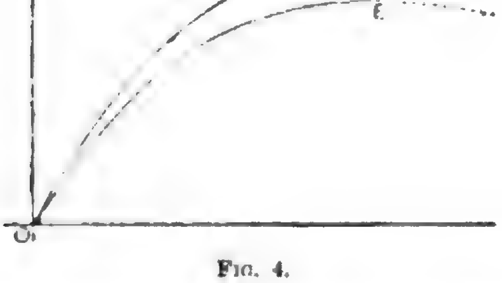

FIG. 4.

(To be continued.)

RECENT DEVELOPMENTS OF ELECTRICITY.*

BY K. L. MURRAY.

What strikes one most when travelling is the enormous rapidity with which applications of electricity have increased—both in number and extent—during the very few years there has been any progress at all.

Some years ago I read a paper upon visual telegraphy before an electrical society, and when prepared it was much struck by the small advance telegraphy had made from the earliest ages until very recent times. It seemed that so long as signalling was only required for military purposes, the system which was sufficient for the requirements of Alexander of Macedon was also good enough for Napoleon Buonaparte. Beacon fires, by which (as is described in the Agamemnon of Eschylus) the news of the fall of Troy was telegraphed to Greece, were also the means used in England to announce the approach of the Spanish Armada, and the semaphore methods, which were almost the only kinds of signals employed until electricity was made use of, were as well known and as widely used in the wars of the Greeks and Romans as in those of European nations at the time of the Battle of Waterloo. Indeed, so wedded were the military authorities in England to the semaphores, that when they were asked to consider the merits of an electric telegraph they declined to do so on the grounds that nothing better than what they were using was wanted. Even instruments for signalling by means of sun flashes, though they (in the form of heliographs) have been recently adopted for use in the English army and have been considered by most people quite a modern invention, were known and used by the ancients. Indeed it would appear as if there was very little new. The idea of the phonograph must have been thought of hundreds of years before Edison produced the one which has made his name famous, if one may judge from the description of an ancient invention, which I had shown me in New York. It was an extract from an old journal and contained in quaint language a description of an apparatus consisting of wheels and cranks so arranged that anything spoken into it would be recorded, and could be reproduced.

When electricity was applied to telegraphy, and when telegraphy began to be used for commercial purposes, immense and rapid strides took place. Still, the first electric telegraph by which the wondrous feat of communicating directly and instantaneously with people far out of sight and hearing was performed, was a very crude and imperfect apparatus compared with the syphon recorders, and such like instruments now in use for the same purpose.

I think I never realised the great developments, and the rapidity with which they were made, until I walked through the South Kensington Museum last year, and looked over the varied assortment of telegraphic apparatus stored there. Specimens of the first electric telegraph—Ronalds's frictional machine, bearing the date 1820; Schilling's needle telegraph, of 1830; Cook and Wheatstone's first needle telegraph which required five line wires, and other similar ones of different makers—all showing progress, but all vastly inferior to instruments worked upon the same principle now. Then Bright's bell telegraph—various A B C telegraphs. The first Wheatstone automatic instrument;

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* Paper read before the Victorian Institute of Engineers, June 3, 1891.

the chemical telegraphs of Bakewell, Wheatstone, Bain, and others, which were designed to enable a person's own handwriting to be recorded at a place far distant from where it was being written; many step-by-step printing telegraphs of various makers, amongst whom the names of Brett, Hughes, Henley, Siemens, and Theiller, brought before my mind the scientists to whom we are so much indebted. Finally, the original Morse dot-and-dash instrument, the simplest and most reliable of all, and which in its much improved form has outlived all others for ordinary telegraphing, and is almost universally used. At the museum, too, are specimens of different kinds of electrical instruments used for railway signalling, also those used for working on long submarine cables from the first one of Sir William Thomson's invention, and hundreds of other sorts of signalling instruments by which the history of the art can be traced from the earliest electrical days down to the present. Batteries, too, and electric lighting aparatus are there, as well as many kinds of machines which illustrate the multifarious uses to which electricity has been put. Indeed, after looking round the collection, seeing from what crude contrivances the splendid instruments of to-day have grown in such a short time, and to how many different uses electricity has been and is day by day being put, what numbers of able and learned men are applying their energies to develop the force, and what immense sums of money are engaged in its development, I felt that those who speak of electricity as the force of the future do not go far enough. It is the force of the present as well as the future; the force which not only transmits our telegrams and enables us to speak to each other, though hundreds of miles apart, with our natural voice; but is doing lighting and many kinds of motor work, and is as surely taking the place of gas and steam for such purposes as it has taken the place of semaphores for, practically, all telegraphic work. Applications of electricity to telegraphing, lighting, and motor work were what I looked for while travelling. At least, I meant to look for them, but they were so numerous everywhere that no looking for was needed.

In Germany, France, England, and America I saw, I think, every kind of instrument used for the transmission of messages—the Morse, simplex, duplex, used to send two messages in different directions at the same time; diplex, to send two messages at once in the same direction; quadruplex, to send four messages at the same time; and multiplex, for sending a greater number, usually at the same time, on the same wire.

The line wire in this case is in electrical connection with the revolving arm of the instrument. A wire brush attached to the arm passes over a number of small segments which form the circle surrounding the axle. These segments are grouped together at intervals and connected to different sets of apparatus worked by the operators. As the arm revolves, the brush is successively brought into contact with each group of segments, and each set of apparatus is thus momentarily connected to the line. The distributor at each end of the line is controlled by a vibrating reed driven electrically. The distributors are caused to run synchronously within a small fraction of a second.

I saw one of these instruments working with accuracy between London and Birmingham. I saw at the same place in London one of the Wheatstone automatic instruments transmitting news to Edinburgh and Glasgow at the rate of about 400 words a minute. The several kinds of needle instruments which are still extensively used on railways and on some submarine cables, A B C telegraphs still used on private wires, where a skilled telegraphist is not available, though they are rapidly giving place to telephones, the various printing telegraphs which mark in ordinary printing letters the messages transmitted. The Phelps electromotor telegraph of this class is used extensively in America. Messages are delivered written in ordinary characters by this instrument on a long strip of paper. I saw in France the autograph telegraph, a very ingenious instrument, which transmits the handwriting of the sender of the message, and also transmits simple drawings, so that it is useful to send sketches or to verify signatures.

Then the many kinds of instruments used for block working on railways naturally interested me. I think I saw every kind used, and was pleased to find that there is not one superior to those we have on our own railways. In America I saw one combined with a pneumatic interlocking apparatus, which is simple, effective, and economical. I stood in a signal-box at an important railway junction in New York, and watched the signal man for an hour. The ease with which he moved the semaphore signals, points, etc., and controlled the movements of trains without leaving his seat pleased me very much, and I believe the system will be largely employed in the future. But I think no telegraph instruments have improved so much as those in use on submarine cables. In 1859 I was engaged in the working of the first cable laid across Bass's Straits, between Victoria and Tasmania. How rough and clumsy were the instruments we used compared with those now employed for cable working.

Transmitting signals over a long submarine cable is a very different matter from doing the same thing over a land line of equal length. A cable is in effect a huge condenser, the insulation separating the conducting wires from the outer metallic covering. The signalling current is retarded very much therefore, so that signals require to follow each other very slowly to be clearly transmitted over the cable. There is a great deal of trouble, too, caused by earth currents, to counteract the influence of which special arrangements have to be made. The receiving apparatus now used in long cables is either a Sir Wm. Thomson's mirror galvanometer or a syphon recorder, the invention of the same eminent scientist. The mirror galvanometer consists of a coil of fine insulated wire surrounding a small magnetic needle, suspended by a silk fibre, and having attached to it a tiny mirror. A lamp is placed in front of the needle and mirror, so that a ray of light will shine on the mirror and be reflected back to a scale. The smallest current passing through the coil of wire causes the needle to move, and as the mirror is attached to it, the reflected ray is seen to move along the scale. A positive current throws the reflected spot of light to the left, which is read as a dot of the Morse alphabet. A negative current sends the spot to the right, which is read as a dash of the Morse alphabet; and so, by watching the movements of the spot of light, the receiving operator reads the message sent to him.

Sir Wm. Thomson designed the syphon recorder to meet the objection that the mirror galvanometer left no record. The principle of the recorder is the opposite of that of the galvanometer. In the latter a magnet moves within a fixed coil of wire, whereas in the syphon recorder a light coil of wire moves between the poles of a powerful magnet. The signal currents pass through the suspended coil, which moves to the left or right as the currents are positive or negative. The movements of the coil are communicated by a thread to a fine glass syphon which is continually emitting ink upon a strip of paper which moves under it, so that the ink marks show the movements of the coil, and the marks being to right or left of a centre line on the paper can be read—a mark to the left being a Morse dot, and one to the right a dash. I saw the latest type of syphon recorder at work, and there seems little left to desire in connection with telegraphing over cables, unless it be a method of doing so more rapidly.

I saw many other kinds of special telegraphing apparatus, such as fire alarm and police alarm telegraphs, both of which are considered indispensable in other parts of the world, and very many domestic telegraphs—annunciators, as they are called in America.

In an hotel where I stayed in New York there was fixed in each room a dial, divided into 25 segments, on each of which was written something which the occupant of the room might be supposed to want. I copied a number of these wants, and found them to be "Manager," "Head waiter," "Hat waiter," "Boot-black," "Bell boy," "Barber," "Window man," "Engineer," "Ice," "Messenger boy," "Milk," "Laundress," "More steam," "Letters," "Wash list," "Chambermaid," "Scrub woman," "Coal," "Carriage," "Morning paper," "Fruit," "Breakfast." A milled screw-head, fixed to a pointer, projected through the glass cover of the instrument. One morning I moved the pointer to "Boot-black." In a few seconds it moved on to zero, showing me that my signal had been received, and in about a minute or so a nigger made his appearance armed with all necessaries for giving me a "shine." That hotel I found to have electrical apparatus in all sorts of places. The doors of the water-closets would not close from outside, but directly I stepped inside pressure on the floor closed a circuit, released a catch, and the door was closed by the force of a spring which held it closed, an enamelled disc on the outside showing at the same time the word "engaged." Burglar alarms were fitted to every window. These consisted of a simple clip arranged so that the least movement of the window would press the two pieces of metal together, so closing an electric circuit which rings an alarm bell and actuates an indicator, which shows the room the signal comes from. A key fastened to the clip is arranged to throw the room out of the circuit if the occupant wishes to open the window wide without ringing the alarm.

In winter the rooms in that hotel are kept warm by steam, and the supply of steam to the pipes is automatically regulated. It was summer time when I was there, so that I did not see the apparatus at work, but the manager told me that it had gone on all right for two winters. A thermometer is arranged so that as soon as the temperature reaches the desired point a contact is made which closes an electric circuit, and by means of an electromagnet cuts off the supply of steam. Directly the temperature falls below the limit the apparatus again works and readmits the steam. The arrangement I saw, and which the manager calls a thermostat, consisted of a strip of brass and one of rubber (materials which expand differently under the same degree of heat) riveted together at one end. This composite strip is marked unequally by changes of temperature, the two pieces being fixed at one extremity while free at the other. There is an appreciable range of movement at the free end. This enables a contact to be made at any point within that range, while a screw adjustment arranges for the contact to take place at any temperature within desirable limits. The thermostats are, it is said, so sensitive as to respond to the change of a single degree of heat.

Similar thermostats are used as fire alarms, when, of course, they are set not to make contact until exposed to a heat of, say, 120deg. to 160deg. Arrangements are made then for the contact to ring an alarm and actuate an indicator, which shows in which room the excessive heat exists. Sometimes it is arranged that the heat indicator and the burglar alarm shall, when they make contact, also light an incandescent lamp—in the former case in each room in the house, and in the latter in the room only whence the alarm was given.

I did not see this in America, but an English gentleman, resident in Vienna, showed me the way it was done in several large establishments there, and in other German cities.

In all the countries I visited I looked up the telephone systems, which I found very much alike in all. Short distance—that is, in and about cities—most frequently done through cables, laid underground or suspended in the air; while long-distance telephony was in all cases done by means of overhead wires. I spoke from Vienna to Prague, and other cities, the furthest distance about 300 miles. In America I spoke over much greater distances; one occasion over 600 miles, always quite plainly and without the smallest difficulty. In Europe it was not always easy to get the information I wanted, owing to the fact that I often visited establishments where the knowledge of English was as limited as as my knowledge of German or Italian. The consuls everywhere were kind enough to send an interpreter with me to the arious electrical places I wished to visit. But talking upon echnical matters through an interpreter who knows nothing about he subject talked of is a tedious process, so that I often left a place only half satisfied.

I found that the question of successful telephony was not one of nstruments but of wiring; if the wiring is properly carried out—properly as regards the conductivity, the insulation, and taking due precautions against induction, almost any telephone will speak all right. When I was in London, Mr. W. H. Preece, chief electric engineer to the Post Office, showed me the arrangements made in connection with the London to Paris telephone lines. It was thought for a long time that speaking through a submarine cable of the length required, and connected to two land lines, would be practically impossible, but Mr. Preece and his assistants went carefully into calculations, and afterwards experiments, and were convinced that it could be done; and the result has proved them to be right, for communication was completed in March last, and the success of the line has been most pronounced. The land line on the English side is of copper; weighs 400lb. to the mile, has an electrical resistance of 2·25 ohms to the mile. It is supported on wooden poles, fixed 70 yards apart. The going and returning wires are made to spirally twist round each other all the way, the spiral being completed at every fourth pole. The line is 85 miles long. The French land line is similar in construction to the English, but the wire is thicker, being 600lb. weight to the mile. Its length is 204 miles The cable connecting the two land lines contains four separate conductors, two for each circuit. Each conductor is a strand of seven pure copper wires, weighing 160lb. per nautical mile, with a resistance of about 7·5 ohms per mile. It is covered with three alternate layers of Chatterton's compound and guttapercha, weighing 300lb. per mile. The insulated wires are twisted spirally round each other, and then served with tanned hemp, on which is laid a spiral sheathing of 16 galvanised iron wires, each 0·28in. thick—a coating of mineral pitch and sand protects the whole.

The cable was laid without any mishap, though very bad weather was experienced at the English end of the work, and when the joints were made with the two land lines, talking between London and Paris was carried on without the least trouble. I had sent me a very interesting description of the whole work, building the land lines, constructing and laying the cable—from which I have taken the extracts I have given. The tariff of charges has been fixed at 10f. for three minutes' conversation between the two cities. It is just 40 years since the first telegraph cable was laid between England and France. Who then would have thought it possible to live to see one laid, over which (and over nearly 300 miles of land) they would be able to talk as plainly as if the person they were talking to was alongside them?

Wires placed under the sea naturally lead me to speak of underground wires. Electrical engineers and managers like to have their wires where they can see them, and the cost of placing wires underground has caused those who have to find the money to fight against underground systems. There is no doubt, however, that all wires in large cities will before many years are over be underground I was a member of a board appointed by the Government here to enquire into the merits of several plans which had been proposed by local men for placing the wires underground. While engaged in that enquiry I looked up all I could of what had been and what was being done in the same way elsewhere. I carried on my investigations about a year later when preparing a paper on the subject, which I read before the Australasian Association for the Advancement of Science, so that I was fairly well posted up in the subject and had a fair acquaintance with its cost and difficulties. It was somewhat of a surprise to me, therefore, to find that in most of the cities of Europe I visited—as well as in the chief ones of America—underground wiring is going on rapidly. The companies had to face the expenditure, and found it not so very dreadful after all. I don't regard overhead wires as so great a nuisance as some people do. It depends chiefly upon the methods of fixing them. Our street pole system is copied from America. Hardly anywhere else did I see lines of poles in the streets of big cities. The wires (those which are not underground) are usually carried over the roofs of the houses, so that they cannot be seen unless one looks for them. Certainly some of the structures on which they are fixed are very ugly when one does see them. The plan suggested by one of our members, Mr. Seitz, in a scheme he laid before the board I have referred to, has always seemed to me to be subject to less objections than most others I have seen, and I cannot think the cost of it would be prohibitive. It was to make channels directly under the paving stones of the footways, in which cables would be laid connecting with an ornamental pole standing at each street corner. This pole would have a chamber in it where connections could be made between the main wires and wires leading to the houses between the poles. Thus, the main wires would be underground and the distributing wires overhead. The poles could be used as lamp pillars, letter-boxes, and for other purposes.

In America, as most people know, there has been great trouble about overhead wires, and the conclusions come to are that in all cities of more than 125,000 inhabitants wires should go underground, but that if they are allowed to remain overhead they must be fixed in accordance with rules, which prescribe the methods of fixing, the sizes of different kinds of wire used, where they are to be fixed and indeed everything connected with them which experience has shown to be necessary in the interests of safety and efficiency.

In the State of New York and in several other States there are boards of electrical control whose duty it is to see that the rules are carried out. Something of the kind should be done here. Either a board of electrical control for Victoria should be appointed, as in America, or, as in England, a branch of one of the Government Departments should have the duty placed upon it of seeing that proper rules for the fixing and working of electrical wires and apparatus are carried out. The rules which were drawn up by this institute in conjunction with the Fire Underwriters' Association, and which have been enforced by the latter body, have done much good, but they do not go far enough, only dealing with wires which affect the safety from fire of buildings insured by the companies.

When I was in London I had the good fortune to be present at a meeting of the Institution of Electrical Engineers, at which Major Cardew, the electrical inspector for the Board of Trade, read a paper upon "Laws and Rules relating to Electrical Conductors, etc." I also heard the discussion upon the paper, and which was joined in by many of the eminent men who were present, and whose knowledge and experience gave much value to their opinions. I was greatly impressed by what I heard, and before I left London obtained from Major Cardew and Sir Thos. Blomfield (one of the secretaries of the Board of Trade), all the English Acts of Parliament and the Board's rules and regulations, with the intention of placing them at the services of whoever may have the duty placed on them, of drawing up an Act of Parliament and rules for use here. I also had given me by the Mayor of New York and the Electrical Superintendent of the city of Chicago the rules connected with the subject in America, copies of boards of electrical control reports, and other papers of interest.

I saw the underground work carried out in a good many European cities, in London, and in America. The systems vary in accordance with the voltage of current used. If low-pressure only is employed, there is not so much danger of leakage as if currents of high tension are used. In the latter case, therefore, much more care is required to insulate the wires, consequently more expense is entailed. In Rome, very high-class cables are placed in wooden troughs. In Vienna, I saw a very costly plan. A brick in cement channel, lined first with asphalte and then with wood soaked in paraffin, was built about 3ft. below the surface of the street. The channel was 18in. across the bottom, which was flat, and 15in. high, the top being arched, and having a slot through which cables were passed down. Troughs made of wood saturated with paraffin were placed on the floor of the channel, and in them very highly insulated and lead-coated cables were laid. The slot through the roof of the channel had a watertight cover fitted to it, so that every precaution was taken to preserve and protect the cables. I asked the engineer, who showed me one of the channels, if it was not dreadfully expensive, and he said that it certainly cost a good bit, but they thought it paid better to do the work thoroughly at first. I said it was well to be him to have command of money enough, at which he smiled and shrugged his shoulders. It seemed to me, indeed, that the system adopted almost always depended upon the richness of the firm or corporation doing the work.

The greatest undertaking in underground work I saw was the Ferranti cable, to carry current of 10,000 volts pressure from the Deptford station into London, there to be transformed into more moderate pressures for distribution to the company's customers. When I visited the Deptford station, I saw the whole process of making the cable, about two miles of which were being made per week. The process is as follows: Copper tube, about 1in. in diameter and ¼in. thick is cut off to a length of 20ft. This is taken to a bench and a sheet of brown paper wound round it. It then goes to the insulating machine, where it has sheets of brown paper previously prepared by being passed slowly through a cauldron full of hot black oil or wax, which soaks thoroughly into the paper, rolled round it as tightly as possible till there is about half an inch of the prepared paper wound on. The insulated tube is then slipped into another copper tube just big enough to receive it, the quantity of copper in this tube being exactly the same as that in the inner tube. Then it is passed through a draw-plate, which squeezes the outer tube very tightly on to the insulation. Then the outer tube is insulated in the same way as the other, and the double tube is then slipped into a protecting case of thin steel tube, in the centre of which a hole is drilled, through which hot wax is forced by a force pump to drive out all air and form a solid mass.

The concentric main thus formed is 20ft. long. The distance from Deptford to the part of London the current is to be taken to is about seven miles, and as there were three mains to be laid down the number of joints was very considerable, and upon the joints being successfully made depended to a very great extent the efficiency of the main. We must remember, too, that the current to be transmitted over it was of 10,000 volts pressure, so that if a weak spot existed it would be found.

After a number of plans for joining the lengths had been experimented with, the following was adopted, and when I was there was said to have proved thoroughly successful: Each length is taken to a lathe, where one end is turned very carefully and smoothly down in a taper of 6in. length from the centre conducting tube back to the outer one. The inside of the inner copper tube is then accurately bored out, and a length of turned copper rod forced into it, so as to make an accurate metallic fit. A sleeve of thin copper tube is then slipped 3in. or so over the end of the outer conductor, which is left bare for the purpose, and is there corrugated down upon it with three corrugations. This corrugating is a very important part of the Ferranti main, as it ensures both good metallic electrical contract and a strong mechanical joint.

The other end of the 20ft. length is treated in a corresponding way to form an exactly opposite contour, into which the end of the next length can be forced tightly; that is, the end is turned out in a hollow coned or taper form from the outside to a length of 6in. When the ends of two lengths are pushed together, the solid rod which projects from the inner copper tube of one length goes into the inner tube of the other length, and the sleeve on the outer tube of one length slips over the outer tube of the other length, and is corrugated on to it. Before the two ends are brought together a sleeve formed of insulated paper covered with a steel tube is slipped on to one of the lengths, and as soon as the processes I have described are completed, the sleeve is slipped over the joint. Hot wax is then forced in, and each end of the steel jointing-piece is corrugated down upon the steel protecting cover of the two lengths thus joined together. When I was in London there was about a mile of the mains laid down and tested with a current of from 16,000 to 19,000 volts pressure, and so far no breakdown had occurred.

The machinery at the Deptford station corresponds with the mains. When completed there will be six improved Corliss engines, two of 1,500 h.p. each, and four of 6,000 h.p. each. Only the two smaller ones were in position when I visited the station, one of them driving a Ferranti alternator, designed to give current of about 100 amperes at 10,000 volts pressure. The engines in use run at a speed of 65 revolutions per minute, with steam pressure of 180lb. The flywheel is 21ft. in diameter, and 8ft. wide, grooved for 40 driving ropes of 5in. girth. There were 12 Babcock and Wilcox boilers in use, 12 more were just fixed, and 24 more will be in position when the station is complete, giving a total steam power of 24,000 h.p. The dynamo in use has an armature which weighs with its shaft fully 25 tons. It runs at a speed of 160 revolutions a minute. The field magnets of this dynamo weigh about 42 tons.

I thought that machine was a pretty big one, but it is a dwarf compared with the two being constructed, the shaft and framework of which I saw. The shaft alone weighs 27 tons. These monsters are to be driven by two engines, one on each side directly coupled to the armature shaft. The output of each of these dynamos is intended to be 10,000 e.h.p.

Of course, there has been a great deal of talk about the Deptford scheme. The idea of using currents of such pressure is declared to be madness; danger is spoken of, and all sorts of failures prophesied. Time will tell. If the Deptford scheme is a success it will reduce the cost of production of electric light very materially. It is much to be hoped therefore that it will be successful.

There was a great electrical exhibition held in Edinburgh last year, and as the Institute of Electrical Engineers held special meetings there, I timed my visit to the Scotch capital so as to be able to attend the meetings. I was well repaid, for I met there electrical engineers from all parts of the world and had the pleasure of an introduction to a good many of them. Fortunately for me a paper upon the lighting of our last exhibition which I had sent to the institution had been read and discussed not very long before, and I found that as the writer of that, and as an Australian, and a past-president of this institute, I was the object of a good deal of interest. Indeed I never was treated so well, had very many more invitations to visit people than I could possibly accept, and was made much of generally.

Besides discussions upon various interesting exhibits, papers were read; one, by pupils of Profs. Ayrton and Perry, upon secondary batteries being especially valuable, as it showed the strong and the weak points of these very valuable, and as they are beginning to be considered indispensable, parts of an electrical light and power system. The results of the investigations and experiments entered into by the professors and their pupils were very satisfactory, as the secondary batteries were proved to be capable of being used under conditions more varied and severe than was before believed possible, and to give out when properly formed and used a much higher percentage of the energy put into them than had previously been obtained from them. I commend that paper, and the lengthy discussion which took place upon it afterwards in London, to the attention of electrical men. As I said at the Edinburgh meeting, I expect some day, when I get a proper place to form and change secondary batteries, to substitute them for the many handfuls of primary cells I have in use working the railway electrical telegraphs, besides lighting the carriages and doing a lot of work which I believe no other electrical machinery can do so well. I saw secondary batteries used for lighting Chelsea, where they were supplying current to about 3,000 lamps, very satisfactorily to the consumers; and the very obliging manager of the company, who showed me all the details of the system, told me that the directors were quite satisfied with the result from a suppliers' point of view. I saw them used for telephone and telegraph work too, and what I saw confirmed me in the belief that whatever a primary battery can do, a secondary can do much more cheaply, and quite as efficiently, as the best primary battery. Indeed, primary batteries—such as the Schanschieff, and others and better ones—can never be extensively used as sources of electricity. Some years ago, experiment proved that, taking the cost of electric current produced by a dynamo machine as one, that of secondary batteries might be set down as four, and primary batteries as 12. Since that time dynamo machinery and secondary batteries have been made more efficient, but I do not think primary batteries have, so that the difference in value between them is now still greater: and when we remember that some of the ablest investigators in electrical science of the present day are devoting much time to improving secondary batteries, and that they are so capable of being improved, I think we may take it for granted that they will be more and more used, and with always increased satisfaction. Among the exhibits at Edinburgh which the members of the Institution of Electrical Engineers examined closely were three I think I should say a few words about.

1. **Electric launches.**—One afternoon, by invitation of the gentleman in charge of the launches which ply along the canal, the members, to the number of about 100, made a visit of inspection to these launches, and were taken about 12 miles down the canal and back. The launch in which I was was driven by a motor which worked up to 2½ h.p. It was supplied with current from 50 secondary cells, placed under the seats, and ran at the rate of eight miles an hour (its maximum speed being 12) exceedingly smoothly and pleasantly. The voltmeter showed that the pressure of current was 109 volts, and the man in charge told me that the voltage was only reduced by six volts after a day's work, in which case the expenditure of energy was certainly small. The gentlemen present, some of whom had considerable experiences of electric launches, said that the cost was very little, if any, more than launches propelled by small steam engines; and I need not say how much cleaner and freer from smell, smoke, and other annoyances, the electric launches were.

Electric launches should be eminently suitable for many purposes, for example, to be used instead of steam launches for warships. No getting up steam; the power is always ready. It occurred to me when reading why the lifeboat did not leave Queenscliff to go the late shipwreck, that electric gear might be fitted to such boats as an auxiliary power. Two or three horsepower might be arranged for and would make all the difference in propelling a heavy boat. I notice lately that the Imperial Government have had an electric pinnace built to convey troops between the Chatham and Sheerness dockyard; her speed is eight knots an hour, and she will carry 40 passengers at a time.

Another of our examining visits was paid to a telpherage line which was doing work in the neighbourhood, carrying heavy goods for a distance of about a quarter of a mile on a steel wire cable suspended about 20ft. from the ground.

The telpherage system has been defined as "the transmission of vehicles by electricity to a distance independently of any control exercised from the vehicle."

It is an attempt when using electricity as a motive power for railways to use a different form of road for the vehicles to travel on, as well a different form of motor and vehicle.

Prof. Fleeming Jenkin, the designer, said that the idea in his mind was that by using electricity as the power one or two or any number of horse-power could be drawn off from different points of a conductor many miles long; it would be of advantage to subdivide the weight to be carried, distributing the load among many light vehicles following each other in a continuous stream, instead of concentrating the load in heavy trains widely spaced apart, so that a cheap, light form of road would be sufficient.

And a cheap light form of road has been adopted, for the vehicles travel on suspended metal cables, which can cross any kind of country without bridges, earthworks, etc , being necessary. No land would require to be purchased, no fences, gate-houses, or any of the other similar expensive adjuncts to railway making would be required. So far only slow speeds have been attained, but where high-speed travelling is not necessary, for conveyance of goods, for instance, in rocky, mountainous countries, from coal and other mines, the telpher system seems admirably adapted. The cost, both of construction and maintenance, is said to be very small as compared even with an ordinary road. There is a telpher line at work in Cornwall, too, carrying materials to and from a mine there, with much satisfaction and economy to the mine owners. I should say that the metal cable which forms the road also carries the electricity to the motors which drive the vehicles.

The gliding railway was another interesting exhibit at Edinburgh. It is not electrical, but we visited it nevertheless. It is based upon two principles: 1. Consists in substituting for the wheels and axles of ordinary railway carriages slides which glide on a thin film of water. 2. Propelling the train by water power under pressure by means of propellers placed at intervals on the line, and discharging water horizontally in the direction of the train into a bucket rack underneath the carriages. The slides are hollow cast-iron boxes, the bottom part removed, but having a furrowed margin. The tender carries water under the requisite pressures for supplying the slides, the water being conveyed from the tender by pipes which pass under the carriage.

When the water is admitted into the hollow part of the slide it naturally seeks to escape, but its exit is impeded by furrows on the margin of the underside of the slide, and at the same time the air is compressed in the upper part of the slide. When the pressure becomes sufficient to lift the slides the water flows out equally on all sides in a thin film, which raises the slides from the rails, and it is said the resistance to the motion of the train is so slight that the tractive force of 1lb. weight is enough to move a ton. All sorts of things are claimed for the gliding railway, but the engineers I heard speak of it expressed doubts as to its value for various reasons.

We paid a visit also to the Forth Bridge, went over it and under it. It is a monstrous and wonderful structure. I went over the underground railway works—the first electrical railway—in London. It was not completed when I was there, but I have within the last few days had a letter from the electrical engineer, who tells me that it is working very satisfactorily indeed, and that many more like it are projected. It is so popular that crowds who want to travel by it can't, and the question of increasing the number of lines is pressing upon the proprietors.

I saw several electric tram systems on the continent of Europe, all giving much satisfaction. One of the engineers of the firm of Siemens Bros. told me that electrical railways were opposed by all sorts of interests. People who are interested in steam motors, in horse trams, farmers who grow horse feed, and dealers who supply it, horse breeders and many others, combine to fight the advance of electric motors for railways. But he said they are the best, and therefore will survive all others, and are increasing in number slowly but surely. He told me of a great electric railway projected in Russia, some hundreds of miles long, the plans and estimates for which were then before the Czar and his advisers. Also of one which he believed would be gone on between Vienna and Buda-Pesth. European engineers, he said, believed in electricity as a motive power, and financiers were beginning also to believe in it.

Italy is a country we are accustomed to consider as being very poor. I was therefore much struck at the magnitude of the engineering works I saw there. I landed at Brindisi, and travelled by rail thence to Naples *viâ* Torento—for about half the distance among the Appenine range of mountains. The railway was for many miles cut through mountains and over great gorges. The train passed out of tunnel after tunnel, joined together by great bridges built over the gorges. I am sure we in this country would not attempt to build such a railway; we would consider its cost prohibitive.

In Rome I found one of the finest electric lighting stations in the world. Money lavished to make everything about it as good as it could be. Indeed, the idea in my mind was that the gas company, to whom it belonged, had a desire to show how expensive electric lighting was. I found, however, that the gas company was so satisfied with the electric lighting that they were arranging for a very much larger station at Tivoli, where is a great water power to be utilised to drive dynamo machines, the current to be carried underground to Rome. In Rome, too, the city authorities were engaged in engineering works; making new streets, and otherwise beautifying, making more convenient and more healthful, and transforming that ancient and eternal city into a modern one.

In other Italian cities I found the same signs of engineering activity, which seemed to me wonderful considering the immense sums of money spent yearly upon naval and military works, and the fact that the immense standing army maintained not only cost so much to maintain, but took so many thousands of men from the ranks of producers.

In America, electricity is everywhere. Every little town has its central station. Arc lamps are to be seen in all the streets, and incandescent lamps in the buildings. Electric trams, too, are very frequent. The mileage of the different kinds of street railways in September of last year was: Horse, 6,043 miles; electric, 2,065 miles; and cable, 501 miles. And day by day the horse systems were, and are being changed to electrical.

In Albany, the State city of New York, I rode in an electric tram which travelled at 12 miles an hour. One part of the route was round a hill, where the curve was considerable, and the gradient 1 in 15. When in New York I met a large number of electrical men from all parts of America. They had come to New York to attend a meeting which is held half-yearly, and at which all kinds of electrical applications are discussed. They all laughed at the idea of any kind of power competing successfully with electricity for all short railways, and even agreed that 10 years would see it applied also on long lines. The use of electricity had given an impetus to underground railways in large cities. New York and Chicago are now seriously contemplating taking their street railways underground. I saw a sketch of one designed for Chicago. Four lines were to be laid, each in a separate tunnel, two to be for an express system and the other two at every street corner.

It is curious when thinking of underground and electrical railways to note that in the *Illustrated London News* of November 10th, 1855, there is a description of a proposed railway to connect England and the Continent under the Straits of Dover, the rails to be laid in iron tubes, the motive power of the railway to be electricity, and the tunnel to be lighted by the same medium.

In America whenever a motive power is wanted electricity is thought of. In mining to transmit power from the top to the bottom of shafts, to crush, haul, and pump, and propel trucks, to break down the products by electrical drills and miners, to light—indeed, to do everything. Fancy a great central plant, dynamos driven by immense engines constructed and worked on the most economical principles, wires led from the dynamos all over the town at any voltage desired, the current transformed at convenient places, and then led about to light the streets and houses, and drive the many kinds of machinery used, not only for propelling tramcars, but driving saws, sewing machines, hair brushes, and the other hundreds of different kinds used in a big city.

I think one of the chief reasons why electrical applications are so popular in America is the fact that they are so much discussed both by journals, and at meetings of societies, "conventions," as they are called. There are very many associations, the members of which meet at more or less frequent intervals, discuss subjects of interest, and have excursions together, and afterwards disseminate in their several centres the information they had gained. People, ladies as well as men, come from all parts of the United States and Canada to attend these meetings, and it is surprising the wide interest taken in them.

At one the following were among the papers read: On Electric Power Tables and Curves, On Primary Batteries, On Photo-Electricity, The Electric Arc, Distribution of Steam from Central Electric Light Stations, Electric Light as used on Railroads, Electric Light Wiring from a Mechanical Standpoint, Underground Conduits, Care of Alternating Currents, Electric Measuring Instruments, Rating the Candle-power of Incandescent Lamps.

I meant to speak of several other electrical matters of interest, including the supply question when using currents of high pressure, the use of transformers, electric meters, and the construction of incandescent lamps, but my notes have already become so long that I must defer doing so to some future occasion, and will conclude by telling you of a visit I paid to a laundry in one of the American cities. I was leaving the next morning, and was told that our washing, the accumulation of two or three weeks, which had been sent out the day before was not yet returned. After making certain enquiries I found that the most sure way to get my shirts, etc., was to go to the laundry for them, which I did accordingly. I found that all the machinery was driven by an electric motor, taking current from the street mains—washing machines, mangling machines, and even ironing machines were electrically worked. The last were in operation and most interested me. They consisted of two hollow cylinders of iron kept hot by means of spirals of wire passing through the inside and which were maintained at a red heat by electric currents. The cylinders rotated slowly, and were kept together by means of spring pressure. Collars were being ironed by being passed twice between the rollers, and the process seemed to answer admirably.

I got my clothes, and had the satisfaction of knowing that if I had not visited the laundry I would have missed seeing the electrical ironing machines, and also would have been detained in the city at considerable inconvenience, or gone away without my shirts.

COMPANIES' MEETINGS.

EDISON AND SWAN UNITED ELECTRIC LIGHT COMPANY

The eighth annual meeting of this Company was held at the Westminster Palace Hotel on Tuesday, the chairman (Mr. J. Staats Forbes) presiding.

The **Secretary** (Major Flood Page) having read the notice convening the meeting, and the report (which with the balance-sheet will be found in our last issue) having been taken as read,

The **Chairman** said: I don't know whether any gentleman has gone through the agreeable exercise I have within the last 24 hours, of reading all the reports from the beginning—that is, in 1884, when the Company began business? We are now dealing with the eighth complete year of the undertaking. I discovered a very singular thing—viz., that all the early reports are what is called very full; there are a great many paragraphs, and they are very long. I have been conversant with the reports of different companies for a good many years, and I find this the characteristic of all these reports—where the dividends are short the report is very long, and *vice versâ*. This seems to indicate that when the company has emerged, as we have done, from mere preliminary difficulties and trials, there is very little to say. It is your acts, not your words, which help you then. How much profit has been made? Well, happily for us, our reports have gradually diminished in length almost as the dividends increased in amount, and this report which is before you to-day is one of the shortest we have ever had, and I hope you think as we do, that it is one of the most satisfactory, because it reveals one or two primary things of some importance—viz., the bulk of the business has increased, and the profit has increased, and we are, happily, enabled to dispense in respect of the year, and of arrears accruing due to the A shareholders, a larger amount than last year or in any preceding year. That is the whole of the story. As I said last year, this class of business—of paying large dividends—is rather a novelty to me, and I have been an apologist for so many reports that I am rather nonplussed when there is nothing to say. The whole story lies in the figures. These joint stock company accounts are not quite so full as those I am in the habit of dealing with, but the essence of them lies in the profit and loss account. Take the first account. On the one side you will see there is income, on the other side the cost of attaining it. I propose to take you through the income in order to compare the year with which we are dealing with the preceding one. Now, take sale of lamps, fittings, royalty on holders, etc., £143,229. 14s. 11d. The corresponding heading last year revealed £118,865. 15s., so that the amount of sales has increased by £24,363. 19s. 10d. The next item is interest, etc., £427. 12s., against £1,442 in the preceding year, a diminution of £1,000 or more, arising from the fact that in the course of the year we realised the bonds of a certain company which paid 4 per cent. interest until we took them over and converted them into money, and of course that affected us. Another item of income is stock on hand. I have had to explain a great many times that we are bound in the very nature of the thing to keep a very large amount of money locked up in stock. There are one or two great types of lamps, the 16 c.p. and some smaller ones, which constitute the mass of our business. But there are a great many lamps of other types, and these are themselves subdivided into types of more or less power, which involves this, that in order to suit the necessities of a great many customers, and the varying conditions of some of them, we are obliged to keep a large supply of lamps on hand or on call. Take this time of the year; these are two of the slackest months of lighting, June and July, but we must have sufficient provision put ready for the darker days of winter. It would not do to postpone the manufacture of lamps until they were wanted. You see what that means. The stocks last year were £56,266, this year they are £59,308. That is a large amount of money to have locked up in any business. I must qualify the amount, however, by saying that a considerable portion of it is not represented by lamps at all, but platinum. We secured a large quantity of it, as I told you last year, at a price which was subsequently greatly exceeded in the market; but we had to find the money for it, and it goes into stock. We have now £15,000 worth of it, and we have a great quantity of manufacturing material which must be in store from time to time.

On the opposite side of the account you will see what the cost of production has been. Dealing with the stock in hand at 1st July, 1890, you will find that we have somewhat increased it by £3,042. Wages, purchases, etc., are £56,362. 19s. 6d. That represents the manufacturing cost at the factory. "Wages" is one of the things which does not diminish. "Purchases" means the material of which the lamp is formed—glass, platinum, carbons, etc. Then come salaries, Directors' fees, rents, etc., then depreciation on plant, written down, as you see, to an extent of £2,160. 18s. 10d., this being, we think, quite a liberal quantity—a very sufficient and prudent quantity, in excess by about £300 of last year. Then comes the balance. Well, the balance is £72,905. 4s. 7d., as against £61,115 last year. That is the result of the trading of the year. I don't know whether you will consider it a satisfactory result? We think it is. We think that £11,790 more profit in the year is rather a good indication of the value of this business. When you see that the output leaves such a considerable profit as £73,000 (nearly), it is not a bad business, and it enables us to recommend you to pay the 17 per cent. to which you are entitled in preference to the deferred shareholders. We have 117,000 £ deferred shares, and, as you know, for a number of years you had no per cent. at all. We must not live in illusions, nor is it very desirable that the outside world should believe that 17 per cent. is the normal condition of this Company. It may be just as well to know that in 1884 we paid nothing; in 1885 we paid nothing, in 1886 nothing, in 1887 nothing, in 1888 nil—and it was only the confidence which the Directors had in the soundness of the thing, and your confidence in the Directors, which carried them through the difficulties of all those years in the face of nothing to divide. Now that confidence has been justified by the results. Once the patent cases were settled; once the Company was got upon its legs it began to pay. And then, in 1889, for the first time we found it prudent to pay a dividend, and we paid 10 per cent. In 1890 we paid 15, and now we propose to pay 17 per cent. Now, that seems a large dividend, and will no doubt excite the cupidity of some people. But if you will divide what we pay by the years we have been working, you will find it comes to 5·5 per cent. per annum. That is the outcrop of that part of the business. On the other side of the account is the balance-sheet. You see how the debtor side stands. The share capital practically remains intact. It has not altered. We have the same number of £5 shares fully paid up and allotted to the Edison Electric Light Company; the same number of shares to the Swan, the same number of A shares, £3 paid, and the same number of B shares fully paid, the total capital being £471,298. You can see that as regards the first three, they are entitled to 7 per cent. cumulative dividend in preference to the B shares. That is why to-day we propose to divide not only the 7 per cent. in respect to the year, but arrears in respect of those years during which you got no dividend. The first item which admits of comparison is the sundry credit balances—a credit balance in the sense of having to pay it. Last year you owed £26,257. This year you owe £14,706. The volume of our trade has been so much larger that we have been able to work our business and owe less money at the end of the year. At the same time, we have transferred a sum to the reserve fund, which now stands at £12,689, as compared with £4,595 last year. Then comes profit and loss account as per appropriation account. We have thought it prudent to pay arrears, after providing for the 7 per cent. on the current year, in respect of the cumulative preference dividend for 1885 at the rate of 3 per cent., and to pay 7 per cent. on the arrears of cumulative preference dividend for the year ending June 30, 1886. But we have got 1887 and 1888 still remaining as a charge on the future, in respect of which you have had no dividend. Going on to the other side of the account—cost of patents, goodwill, preliminary outlay, loss on working, etc., and further expenditure thereon—£238,064. Now that further expenditure thereon is in respect to payments that cropped up for legal expenses and patents in connection with the founding of the Company. Against that we wrote off amounts in respect of plant out of date and superfluous, forming part of the original price in the amalgamation—that brings the amount down to £234,638. If you cast your eyes further down the account, you will see that the amount of B shares issued *as per contra*, is £117,820. This is a mere matter of bookkeeping. Then comes the Manchester Edison-Swan Company, Limited, with 100,000 B shares at £12,000. That is a deferred interest we have got in that company. Whether it will be worth anything or not, time only can reveal. Some day it may be a useful asset. Then you come to the other offsets—freehold property, £45,012; plant and stock, £83,188, as against £77,000 last year. During the year, in anticipation of future work, and in order to meet current pressure, we have been obliged to extend our factory considerably, put up new gas works, and new glass-blowing works, all under the pressure of a growing business. The money you see represented there as £45,000. We bought the property originally very cheap, and I have no hesitation in saying that if that property were valued to-day as a going concern it would be worth more than £45,000. If we had had to buy land and build a factory we could not have done it for the money. Fortunately, we found a place with ample land and with the structure of a factory upon it. The people who had bought it made an enormous loss, and we got it cheap. Debtors are put down at £34,859. 1s. 9d. Last year they were £15,203. Setting those debtors to us—and they are all good—against the debts we owe on the other side, £14,706, you will see that the money owed to us is about double that we owe. Investment in Consols at cost £20,000 and cash at the bankers and in hand £8,051 finishes that part of the business. Now comes the appropriation of the £72,905 carried from profit and loss account. You will find that, on the other side, amongst other things we originally took over in 1884 was a quantity of machinery, installations, and all sorts of things, the fruit of the want of knowledge of the two original companies, the Edison and the Swan. They had made a lot of bad bargains, and had bought a lot of stuff which had turned out badly—dynamos, etc. They had a lot of installations on the theory that rental of light was a very profitable thing. But it was exceedingly ruinous. We held that it was wise to cut our first loss, but those other men were such babies that they hesitated to realise their loss at the right moment. We realised the loss, and got rid of all these things upon the best terms we could, and this is the very last of them. We had a lot of dynamos which were useless to us, but we managed to sell them in Italy. We have got rid of them all. Then comes the dividend for the year ended June 30. Then the interest on the A shares for 1885 is wiped out, and then comes 7 per cent in respect of 1886. We thought that was going far enough, and therefore carried the balance (£9,388) to reserve, and if you will kindly approve of the recommendation of the Board—because it is in your hands—you will add that to the reserve already set aside, and you will have £22,000 reserve. That is the bare bones of this account. But there is one thing I should like to call your attention to. Of course we are face to face now with this. There is so much capital—a very large sum of money—patents are running out—two years and a few months; and then—the future! Well! one looks with some anxiety upon a past of the kind we have experienced. Cost of patents, etc., as per last balance-sheet—you see that boils down now to £234,638. 17s. 7d. A considerable amount! But I don't think it is an amount about which we need be alarmed. This is the cost of founding this business and carrying it through to that moment when we shall be in competition with all the world. Well! I suppose you will have the most—it is not vain to say it, it would be silly if we could not say it—the most perfect lamp factory in this, and probably in any other country; and we trust that by that time you will have the best reputation in any country. You will have the great perseverance and exceeding skill of your technical advisers, as well as the zeal of your officials and Directors to establish a going concern on a very large scale. This business cannot be conducted on a very large scale, however, without investing a large sum of money, therefore competitors will have to compete with us who are thoroughly equipped, high in reputation, and thoroughly established. Of course we shall have to take our chance in the future, but it will come to this, that you have had a protected period; and if you are able to make a better lamp, or at all events as good a lamp at a price below that of any small maker, or, indeed, any very considerable maker, you can take your chance with the public. It is the old thing—Huntley and Palmer's biscuits—a good reputation, cheap production, and quantity. If we can double our sales we can afford to take a very modest profit on the output; because in a concern of this sort fixed costs are a very material element. We are not dependent merely upon the lamp patent (as I am reminded by our secretary), but we have patents in respect to very important parts of the lamp, holders, fittings, and so forth, which extend a long time beyond the lamp patents, and from which we hope to derive a very considerable annual income in the shape of royalties. You are not only now paying this arrear of dividend with every prospect of this being continued in the future, but you have in the interim between 1884 and 1891 written down £300,988 to £234,600, and this has been done out of profits; some of it out of sales of superfluous plant and property, but most of it out of the profits. We kept writing down, and writing down, and writing down, before we paid any dividend at all. We said the losses of the business must be compensated before we did so. And that is why you got no dividend. Not because there was no balance made on trade working. The other item is equally satisfactory. You started in 1884, besides your £301,000, with what may be called a living asset—freehold property, interest, etc., £52,000. You have got in the same items this year a good deal more than £52,000, and therefore you are in this happy position. Your original claim, which would have to be liquidated, has been reduced by £66,000, and to put it very roundly—(without going into detail; we are obliged to keep a good deal to ourselves, because a good many people would like to know how and where we make our profits. They may induct as much as they like, but induction is not as good as positive information. Therefore, we have good reason for going in for generalities)—roundly speaking, your position in diminished claim in respect of original outlay, and improvements in your investments may be put down as something like £125,000. I think that fact, coupled with the dividend you are getting now, should be taken as not altogether discouraging. With these remarks, and of course subject to the readiness to go into any further detail and answer any questions, I beg to move that the report and accounts for the year ending June 30, 1891, be received and adopted.

This was seconded by **Mr. F. R. Leyland.**

Mr. Pell asked whether all the lamps were made by the Company and were they marked "Edison and Swan"?

The **Chairman**: Yes, the bulk are made by us. We import a few from Mr. Edison. His are marked "Edison," and ours "Edison-Swan."

Mr. Pell had seen a great number not marked at all.

The **Chairman**: Perhaps it is as well that proprietors should remember that every incandescent lamp used anywhere ought to be an Edison-Swan lamp. If they find one that isn't and will let us know, it will give us a reason for knowing why.

Another shareholder wanted to know what number of lamps was represented by the figures £143,229?

The **Chairman**: That is a bit of information I cannot give you. It would be very useful to our opponents. We have a great diversity of lamps and many different makes at very varying prices, but it is not to our interest to reveal the price of any particular one.

Mr. Hedges remarked on the difficulty he had in dealing with his Swan United shares. He thought they ought to face this matter. Couldn't they get a quotation on the Stock Exchange for them?

The **Chairman** explained that the difficulty with regard to these shares arose from the Edison having been launched into the undertaking under very different circumstances to the Swan. The Swan Company had foreign patents and they kept them up, and the difficulty was that they held the major portion of the shares in this Company, but could not distribute. The Board had tried to arrange the matter, but so far unsuccessfully; it must be dealt with by negotiation.

In reply to another shareholder the **Chairman** explained that they had retained the absolute right to manufacture and sell lamps, and they did this in preference to licensing other makers. But with regard to holders, the same reasons against licensing did not hold good, and they had licensed some eminent firms to make holders.

Replying to a further question and suggestion the **Chairman** said that they had gone on the theory of making things safe. He remembered a time when matters were not quite so pleasant as they were now. The Board desired to safeguard the proprietors. He then put the resolution adopting the report, which was carried unanimously.

The next resolution, moved by the **Chairman**, was the declaration of the three different dividends (*vide* report), which was seconded by **Mr. F. R. Leyland** and carried unanimously.

Mr. Forbes then vacated the chair, and his re-election was moved by **Mr. Leyland**, in eulogistic terms, seconded by **Viscount Anson**, and carried *nem. dis.*

Mr. Leyland was then unanimously re-elected a director on the proposition of **Mr. Forbes**, seconded by **Mr. E. Villiers**.

The re-election of the auditors, Messrs. Welton, Jones, and Co., concluded the proceedings.

DIRECT UNITED STATES CABLE COMPANY.

The twenty-eighth ordinary general meeting of this Company was held on Friday, 17th inst., at Winchester House, Sir J. Pender presiding.

The **Chairman** stated that the revenue for the half-year ended the 30th ult., after deducting out-payments, had been £37,353, and the working and other expenses, including income tax, but exclusive of the cost of repairs, had been £18,113, leaving a balance of £19,240 as the net profit of the half-year, which was increased by the amount brought forward to £24,750. An interim dividend of 3s. 6d. a share for the quarter ended March 31 had been paid, and they now proposed a final dividend of 3s. 6d. a share for the quarter ended the 30th ult., leaving £3,502 to be carried forward. The revenue had shown a falling off of £2,664 as compared with that of the corresponding period of 1890, owing to slackness of business, to some curtailment of trade in consequence of recent fiscal arrangements of the United States Government, and to the temporary loss of traffic with the West Coast of South America through the war in Chili. The investments, which had been increased from £234,993 to £244,652, were entered in the balance-sheet at cost, which was a figure considerably below their present market value. He wished that their prospects enabled him to say that they might soon return to the dividend of 5 per cent. which used to be paid by that Company; but he reminded them that at that time there were only six Atlantic cables, whereas since then another cable had been laid by the Western Union Company, while two more had been put down by the Commercial Company. Since their last meeting the French Courts had, he believed, decided the suit they were engaged in in the English company's favour. He did not, however, wish them to be too sanguine about the money which they might get as the result of the decision.

The report was adopted, and the dividend declared.

COMPANIES' REPORTS.

CROMPTON AND CO., LIMITED.

Directors: H. H. J. W. Drummond, Esq., Bernard Gibson, Esq., Viscount Emlyn, Carleton F. Tufnell, Esq., and Rookes Evelyn Bell Crompton, Esq., and John Francis Albright, Esq. (managing directors).

Third report of the Directors to be presented at the annual general meeting at the City Terminus Hotel, on Wednesday, the 29th July, at 2.30 p.m.

The Directors beg to submit to the shareholders the third annual statement of accounts and balance-sheet made up to the 31st March last. The business of the Company continues to increase, the order-book is well filled, and negotiations are on foot for several important central station contracts, in addition to those at present in hand. The Directors have given considerable attention to improved arrangements at the Chelmsford works for increasing the output, so as to ensure punctuality in the execution of orders. The fitting up of the London works, referred to in the Chairman's speech at the general meeting last year, has also been completed. These alterations and additions have entailed a rather heavy outlay on capital account. Mr. . F. Albright, one of the managing directors, has been on an extensive tour through Canada, the United States, Australia, India, and the Cape, visiting the different agents of the Company, and making arrangements which, it is hoped, will lead to a considerable extension of the Company's business abroad. The date appointed for the meeting of the shareholders has been delayed, to allow for Mr. Albright's attendance on his return to England. The net profits of the year amount to £13,030. 14s. 7d., and after providing for the debenture interest and other payments set out in the revenue accounts, and deducting the interim dividends already paid on both the preference and ordinary shares, there remains, with the £474. 18s. 10d. brought forward from last year, a balance available for dividend of £6,484. 18s. 10d. The Directors propose, after setting aside a sum of £500 as a provision for doubtful debts and contingencies, to declare a dividend of 3s. 6d. per share, making 7 per cent. per annum upon the preference shares, and 5s. 6d. per share—making, with the interim dividend, a total of 8 per cent. per annum—upon the ordinary shares, carrying the balance forward. Sir Charles Grant has retired from the Board, and the Directors have elected Mr. H. H. J. W. Drummond and Viscount Emlyn to fill this vacancy and that caused by the death of Viscount Torrington, mentioned last year. In accordance with the articles of association, Mr. B. Gibson retires from the Board of Directors by rotation, but offers himself for re-election. The auditors, Messrs. J. H. Duncan and Co., also offer themselves for re-election.

STATEMENT OF LIABILITIES AND ASSETS AT 31ST MARCH, 1891.

Capital and Liabilities.

Dr.	£	s.	d.	£	s.	d.
Authorised issue 28,000 shares at £5	140,000	0	0			
Ordinary shares, 8,000 issued as fully paid	40,000	0	0			
Preference shares, 20,000 at £5	100,000	0	0			
				140,000	0	0
Debentures issued				31,050	0	0
Loan from bankers				10,000	0	0
Sundry creditors				31,317	13	2
Doubtful debts and contingencies account				464	13	5
Reserve fund				568	0	0
Revenue account balance				6,484	18	10
				£219,885	5	5

Cr. *Property and Assets.*	£	s.	d.
Freehold property and ground rents	19,309	2	1
Stock-in-trade, plant, tools, furniture, fixtures, etc.	66,903	2	9
Installations (including balance of working account to March 31)	13,265	5	7
Trade debtors	47,299	19	9
Investments in shares of other companies	16,751	0	0
Loans at interest to subsidiary companies	6,905	8	11
Cash at bankers and in office	8,941	6	4
Preliminary expenses—suspense account	500	0	0
Patents account	10,010	0	0
Goodwill	30,000	0	0
	£219,885	5	5

PROFIT AND LOSS ACCOUNT FOR YEAR ENDING 31ST MARCH, 1891.

Dr.	£	s.	d.
Trading and office expenses, salaries, agencies, etc.	17,058	3	0
Repairs to buildings and plant	1,532	11	8
Depreciation of plant and machinery, patents, and fixtures	2,087	4	7
Balance carried to revenue account	13,030	14	7
	£33,708	13	10

Cr.	£	s.	d.
Gross profit and trading account, pupils' premiums, profits and dividends on investments	33,708	13	10
	£33,708	13	10

Dr. REVENUE ACCOUNT.	£	s.	d.	£	s.	d.
Interest on debentures and mortgages				1,019	5	5
Preliminary expenses (written off)				338	5	0
Directors', trustees', and auditors' fees				1,111	11	4
Interim preference dividend paid December, 1890	3,406	5	4			
Interim ordinary dividend paid February, 1891	975	0	0			
Income tax	170	7	6			
Balance available for present distribution	6,484	18	10			
				11,036	11	8
				£13,505	13	5

Cr.	£	s.	d.
Balance from last year	474	18	10
Net profit from profit and loss account	13,030	14	7
	£13,505	13	5

GLOBE TELEGRAPH AND TRUST COMPANY.

The report of the Directors for the year ending July 18th, 1891, states that the net revenue of the Company, after deduction of expenses, amounts to £201,699, which, with the balance brought forward, makes a total of £201,818. From this amount there has been distributed the sum of £133,059 in interim dividends, leaving an available balance of £68,758. The Directors recommend the payment of a final dividend for the year of 3s. per share on the preference shares, and of 4s. 6d. per share on the ordinary shares, making, with the former distribution, a total dividend for the year of 6 per cent., less income tax, upon the preference, and 5¼ per cent. net upon the ordinary shares (against 5 per cent. for the preceding year), and carrying forward a balance of £1,877. The Imperial German Government have taken over the German-Norwegian Telegraph Company, and will pay off the capital at par. This Company held virtually the whole of the capital, which is now being paid off. The sum repaid has been £66,956, and the balance will be paid next year. The Directors have reinvested most of this capital in shares of the Western Union Telegraph Company and the American Cable Company. There remains a small balance still to reinvest.

CITY NOTES.

City and South London Railway.—The receipts for last week were £689, against £692 for the week ending 11th inst.

West India and Panama Telegraph Company.—The receipts for the half month ended July 15 were £1,981, against £2,858.

The Spanish National Submarine Telegraph Company announce an interim dividend of 2s. a share, payable on 31st inst.

Anglo-American Telegraph Company.—The Directors have declared an interim dividend for the quarter ending June 30 of 12s. per cent. on the ordinary and £1. 4s. per cent. on the preferred stock, less income tax, payable on the 1st of August to the stockholders registered on the books of the Company on July 14, 1891.

Venezuela Telephone Company.—The Company state that the half-yearly interest on their debentures, due on 31st inst., will be paid on presentation of the coupons, either in Amsterdam or at the Consolidated Bank, London. The gross earnings, including estimated returns for May and June (the end of the financial year), based on the April returns, were £16,258 and the net earnings £6,655. The proportion of working expenses to gross earnings had been abnormally large during this period, owing to the fact that the works during the whole of the year 1890, and up to the present time, have been under reconstruction and rearrangement.

NEW COMPANIES REGISTERED.

Italian Electrical Light and Power Company, Limited.—Registered by A. W. Rixon, 10, Austinfriars, E.C., with a capital of £60,000 in £4 shares. Object: to carry on every description of business connected with the generation, supply, and use of electricity for the purposes of light, power, or otherwise. The first subscribers are:

	Shares.
G. Taddei, 83, Via Arenula, Roma	1
P. Alessandri, 92, Via dei Farnesi, Roma	1
J. Reid, 101, Leadenhall-street, London	1
C. E. Stuart, 4, Aberdeen-terrace, Highbury	1
A. P. Windridge, 344, Stanstead-road, Catford	1
T. Wholey, 7, Storey's-gate, S.W.	1
J. Carr, 35, Paget-road, Stoke Newington	1

There shall not be less than three nor more than eight Directors; the first are to be determined in general meeting. Qualification, 25 shares. Remuneration, £50 each per annum, the same to be divisible as they shall think fit.

PROVISIONAL PATENTS, 1891.

JULY 13.

11886. **Improvements in electric arc lamps.** Alexis Cance and Société Anonyme d'Appareillages and d'Eclairages Electriques (Lampes Electriques Cance), 28, Southampton-buildings, London.

11891. **Improvements in and relating to switch devices for effecting the connections in telephone systems.** William Phillips Thompson, 6, Lord-street, Liverpool. (Johann Dietz, Germany.) (Complete specification.)

JULY 15.

11978. **A system and apparatus for the evolution and diffusion, by electrical energy, of disinfectants, antiseptics, and substances of a like nature.** Alfred René Upward, 150, Holland-road, Kensington, London.

12004. **An improved microphone transmitter.** Richard Whitehead and Alfred Doxey, 7, Well-road, Heeley, Sheffield.

12014. **Improvements in telephonic transmitters.** Arthur Thomas Collier, Alexander Marr, and William Fereday Bottomley, 70, Market-street, Manchester.

12019. **Improvements in the manufacture of carbons for electric arc lamps.** William Lloyd Wise, 46, Lincoln's-inn-fields, London. (The Rheinische Fabrik for Elektrische Bogenlichtkohle W. Grüdelbach, Germany.)

12018. **Improvements in electrical gear for steering ships, and controlling the movement of holophotes, guns, and the like.** Ernest Wilson, 88, Church-lane, Charlton, Kent.

12036. **Improvements in primary batteries.** Samuel William Maquay, 55, Chancery-lane, London.

12040. **Improvements in voltmeters.** Alfred Herbert Dykes and William Benison Hird, 28, Southampton-buildings, London.

12046. **Improvements in or relating to electric motors.** Johann Sahulka, 323, High Holborn, London. (Complete specification.)

JULY 16.

[illegible]. **An improved electrode plate for electric collectors.** Hugh Donald Fitzpatrick, 70, Wellington-street, Glasgow. (Karl Ferdinand Schöller and Rudolf Herman Jahr, Germany.) (Complete specification.)

12070. **An improved method of reciprocating the anchor of an electric apparatus.** Hugh Donald Fitzpatrick, 70, Wellington-street, Glasgow. (Karl Ferdinand Scholler and Rudolph Herman Jahr, Germany.) (Complete specification.)

12099. **Improvements in electric meters.** Samuel William Maquay, 55, Chancery-lane, London.

12106. **Improvements in and relating to electric lamps or lighting apparatus.** Frédéric Victor Maquaire, 45, Southampton-buildings, London.

12107. **Improvements in drops or suspending mechanism for electric light and other like fittings.** Willard Elbridge Dow, 45, Southampton-buildings, London. (Complete specification.)

12117. **Improvements in electric current meters.** Eugen Hartmann and Wunibald Braun, 47, Lincoln's-inn-fields, London. (Complete specification.)

JULY 17.

12133. **Improvements in the automatic contacts of incandescent lampholders.** Reuben James Bott, 22, Southampton-buildings, London.

12150. **An improved electromotor adapted to clockwork machinery.** William Rutton May, 5, Lime-street, London.

12188. **Improvements in and in connection with incandescent electric lamps.** Richard Henry Barrett, 24, Southampton-buildings, London.

JULY 18.

12243. **Improvements in magnetic compasses.** Pieter Jan Kaiser, 27, Southampton-buildings, London. (Complete specification.)

12244. **Improvements in portable electric lamps.** John Sutton Nettlefold, 7, Staple-inn, London.

12257. **Improvements in the manufacture of electric incandescence or glow lamps.** Paul Scharf and Rudolf Latzko, 53, Chancery-lane, London. (Complete specification.)

SPECIFICATIONS PUBLISHED.

1890.

11817. **Electric light fixtures.** Aldrich. 8d.

11862. **Electrostatic measuring instruments.** Ayrton and Mather. 8d.

12915. **Dynamo electric motors, etc.** Jarman. 8d.

13129. **Safety fuses for electrical circuits.** Slater. 8d.

13232. **Magnetic separators.** Wise (Finney). 11d.

13256. **Coin-freed electrical apparatus.** Gent and others. 8d.

13260. **Distribution of electricity.** Dobrowolsky and Mamroth. 8d.

14050. **Electrical cut-outs.** Siemens Brothers and Company, Limited (Siemens and Halske.) 6d.

14609. **Electrically propelled vehicles.** Mills (Jobson). 8d.

1891.

1599. **Stopping waterwheel used in generating electricity.** Elliot. 8d.

6378. **Electric motors.** Depoele. 8d.

8648. **Producing electric light and cold.** Bazin. 8d.

8922. **Electric clocks.** Prentiss. 8d.

8924. **Electric circuits.** Lake (Kaliske). 6d.

8932. **Electric locomotives.** Lake (Eickemeyer). 1s. 3d.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Brush Co.	—	2⅛
— Pref.	—	1⅜
India Rubber, Gutta Percha & Telegraph Co.	10	19½
House-to-House	5	5
Metropolitan Electric Supply	—	10
London Electric Supply	5	2
Swan United	3½	4½
St. James'	—	7
National Telephone	5	5
Electric Construction	10	7¼
Westminster Electric	—	5

NOTES.

The Central London Railway Bill was read a third time before the House of Lords on Monday and passed.

Spandau.—The Thomson-Houston Company have obtained a concession for 50 years for an electric railway at Spandau, near Berlin.

Telephonic Extension.—A supplementary trunk line of the National Telephone Company has been completed this week between Edinburgh and Penicuik.

History of Electricity.—The "Chronological History of Electricity," by P. F. Mottelay, appearing in the *Electrical World* is also being published in *Engineering*.

Eastwood House.—On Monday night Captain Selwyn's new hall, Eastwood House, was opened, and the electric light shone on his house-warming meeting.

Electrical Work in Mines.—Before the South Wales Institute of Engineers last week, Mr. Albion T. Snell read a paper entitled "Notes on Electrical Work in Mines."

Telephones in Holland.—The Chamber of Commerce at Breda, Holland, has expressed its desire that the Dutch Government should buy up the telephone service and work it as a State department.

Rechniewski Dynamos.—We learn that Messrs. E. L. Berry, Harrison, and Co., have been appointed sole agents in England for the Rechniewski dynamo, which earned high praises and a gold medal at the Paris Exhibition.

Hampstead.—A long discussion took place on the question of electric light at the last meeting of the Hampstead Vestry, at which Mr. Preece was specially invited. The discussion and consideration was left over till October.

Sunderland.—At the last meeting of the Sunderland Highways Committee the borough engineer reported that he had received several replies to his enquiries from other towns with regard to the electric light, and the matter was referred to a sub-committee.

Asbestos Goods.—The United Asbestos Company, Limited, has for the seventh time secured the contract for the supply of all kinds of asbestos goods required for use in her Majesty's Navy during the ensuing 12 months, including packing, sheeting, cloth, and millboard.

St. Pancras.—Mr. James T. Baron has been appointed chief engineer and general manager to the St. Pancras Vestry for their central station supply department. Mr. Baron was Mr. Wilson Hartnell's outside general manager, and has had much experience in important work.

Paris Lighting.—At a meeting on the 24th inst. the Paris Municipal Council granted to M. Victor Popp the concession for electric lighting of the Entrepôt de Bercy. The lamp hour of 10 c.p. is fixed at 1·8 centimes or 0·18d. At this price everyone would be able to use the light.

Ventilating.—Messrs. J. D. F. Andrews and Co. have, in conjunction with others, purchased the patents, goodwill, and assets of the D. C. Green Ventilating and Engineering Company, and are now fitting an extensive installation of the D. C. Green system of ventilation on board the s.s. "Ophir."

Trinidad and Tobago Cables.—In the House of Commons, on the 23rd inst., in answer to Admiral Field, Baron H. De Worms said the importance of establishing telegraphic communication with Tobago has not been overlooked, and it is hoped that the revenue of that island may before long be able to bear the cost.

Akester Electric Motor Company.—A meeting of this company was held on Monday at Cannon-street Hotel. The proceedings were private. This company was formed to carry out the patents of Mr. Akester in tramway work, and a car was built some time ago and run experimentally at Messrs. Stephen Smith's works at Millwall.

Phonopore.—Those who wish to investigate the properties of Mr. Langdon-Davies's phonopore will have the opportunity to do so in a pamphlet on the "Phonopore Duplex Telegraph," giving full particulars as to working, with drawings, published (in French and English) at 2s. by the Phonopore Syndicate, Blomfield House, E.C.

Khotinsky Accumulators.—The firm of Betts and Co., of Carcassone, have acquired the French patents of Khotinsky for accumulators. The Khotinsky Company have for eight years made these accumulators with much success. They are similar to the Betts accumulator, and the combination is known as the "Khotinsky-Betts" cell.

Gas v. Electricity.—The North British Association of Gas Managers held their thirtieth annual meeting last week in Edinburgh. The president, Bailie Robertson, in his inaugural address, alluded to the rivalry of electricity, but did not consider it had affected gas interests, nor in any way curtailed the sale of gas. He was inclined to look upon paraffin as a far more serious rival.

Society of Arts.—The Prince of Wales at Marlborough House on Monday presented the gold medal of the Society of Arts to Mr. W. H. Perkin, for his discovery of producing colouring matter from coal tar; and to Sir Frederick Abel, for his researches in the manufacture of iron and steel, and his services to the State with reference to war material, and as chemist to the War Department.

Reigate.—The Reigate Town Council on Tuesday resolved that an application be made to the Board of Trade for a provisional order under the Electric Lighting Acts, and that the Mayor (Mr. S. Brookes) be requested to cause the necessary steps to be taken for the carrying out of this resolution, assisted by the borough engineer, Mr. F. D. Clark, A.M.I.C.E., and the town clerk, Mr. C. J. Grece, LL.D.

Cricket.—The return match between a team got up by the *Electrical Review* and *Electrical Engineer*, and one representing Mr. Ronald Scott's electrical works at Acton, was played in Mr. Scott's grounds on Saturday last. The weather was perfect, and an enjoyable game resulted in a well-deserved win for the Acton team. After the match, the visiting eleven were hospitably entertained by Mr. Scott.

Berlin Gold Medal.—From Berlin it is announced that the large gold medal for science has been conferred upon Prof. Du Bois-Reymond, M.D., F.R.S., member and secretary of the Royal Academy of Sciences in Berlin, and director of the Physiological Institute. The professor is best known for the important services he has rendered to science by his researches in the department of animal electricity.

Literature.—We have received the fourth yearly number of the *Fortschritte der Elektrotechnik*, containing summary of electrical progress of the year, references to important articles in technical papers, and description of the work of Messrs. Siemens and Halske, Schückert and Co., and the Allgemeine Company of Berlin, for the Government departments. To those who read German it is a most valuable epitome.

Paris Lighting.—*Electricité* last week has a long article by M. Frank Geraldy upon the electric lighting of Paris, specially describing, with illustrations of machinery and mains, the Montmartre central stations. The mains are bare cables in a concrete culvert, kept apart by insulators bolted down with iron bolts. Details of the immense eight-pole dynamos made by the Continental Edison Company are given.

Electrical Haulage.—An important step in colliery enterprise in South Wales was made at Abercainaid, Merthyr Tydfil, last Friday, by Mr. F. A. Hankey, M.P., managing director of the Plymouth Colliery Works, and Mrs. Hankey, by the introduction of electrical haulage at Abercainaid Colliery to supersede horses. The installation was carried out by Mr. J. C. Howell, of Llanelly and London. The trial proved very successful.

Bombay.—In commenting upon the action of the Bombay Municipality in the matter of electric lighting, an technical paper asks: "Why not call for estimates for lighting the restricted area now chosen for a period of, say, five years, so that the firm undertaking the work will have some inducement to make full and adequate provision for the success of the experiment? A further proviso that in the event of the experiment proving satisfactory, the period would be prolonged for a period of two or three years, would stimulate enterprise."

Southampton Electric Cranes.—The Southampton Works Committee reported that Mr. J. G. W. Aldridge, the electric engineer, had submitted specifications and form of tender for electric lighting on the Royal Pier with mains and all accessories, and detailed estimate of £509. It was decided to recommend the Board to advertise for tenders. Specifications for two electric cranes on the quay, with mains and all accessories, were submitted, with detailed estimate at £2,461. The agreement with the electric light company was carried.

Cardiff.—Some of our contemporaries are a little in error when alluding to Mr. Massey's appointment as electrical engineer to the Cardiff Corporation, which has been made to appear as if it was a recent arrangement. The fact is that Mr. Massey has already acted for the Corporation for about a year, and helped them with their provisional order. All that was done the other day was to instruct a small committee to examine and report upon, with Mr. Massey's assistance, the electric lighting installations that have been carried out by other towns.

Newington.—The Special Purposes Committee of the London County Council report that they have determined to provide electric lighting at the new weights and measures office at Newington, and have invited tenders for the work of providing the installation. The tenders have not yet been received, but it will be desirable that no delay should occur in carrying out the work, as the office is in course of erection. They recommend that they be authorised to enter into any necessary contract for the provision of electric lighting at the Newington weights and measures office.

Observatory on Mont Blanc.—A project is being mooted in Paris for the erection of an observatory on Mont Blanc. M. Janssen made an appeal last year for support in this undertaking, and on Tuesday at the Academy of Sciences he announced that his appeal had been heard. He has obtained the support of M. Bischoffsheim, Prince Roland Bonaparte, Baron Alfred de Rothschild, member of the Academy of Fine Arts, and M. Eiffel. As the observatory will have to be set on solid rock it is intended to find a point where the ice is not over 30ft. thick. It is thought the preliminary work will be undertaken at once.

Lyons.—We have already mentioned the project for the utilisation of 12,000 h.p. of the Rhone at Lyons. The municipal committee appointed to discuss the project have reported favourably. Motors of about a horse-power would be greatly in demand amongst the silk weavers, and the power from the turbines might be well utilised at night for lighting purposes. The concession of the gas company expires in 11 years. Meanwhile, they look to the Compagnie de Jonage to carry out the electrical part of the scheme and organise the distribution of electric power.

Pipe Welding.—An interesting description of the first pipe welding plant in Chicago, with illustration of the machine in action, is given in the *Western Electrician* for July 11. The pipes are required for icemaking machines. The generator is a 30,000-watt machine, which delivers current in the primary of the welder at 300 volts, the maximum current being 150 amperes. The welds are made in about 15 seconds, but the number of welds per day, including time handling, is about 225. An average of 55 h.p. is required to weld the 2in. heavy iron pipe. All coils are tested after welding to 500lb. per square inch.

A New Switch.—The *Elektrotechnisches Echo*, No. 29, describes a new switch (with illustrations), which has for its principles the progressive pushing forward of wedge-shaped contacts of a peculiar design. Some of the wedges are furnished with brass facings and some left blank and thus insulated. The continued turning in one direction puts successively contact on and off, and the switch can be used for switching on one, three, or five lamps, etc., or a couple of these switches can be also used for lighting a circuit from either end of a room. They are shown in single and double pole form, and mark a useful type of switch for special purposes.

Prudhoe Hall.—The opening ceremony recently took place of a new Catholic chapel in the North of England at Prudhoe Hall, the residence of Mrs. Liddell. The interior is very handsome, carried out to the designs of Messrs. Dunn, Hansom, and Dunn, architects, and is capable of seating 200 persons. The hall itself is undergoing extensive alterations and additions, and is being fitted up throughout with all the most modern contrivances for comfort and convenience (such as electric light, with which the chapel is also lighted), in a manner which will make it one of the largest as well as one of the best appointed mansions in the county.

Bi-telephones.—M. Mercradier, having had to use microphones in delicate measurements, has found occasion to require forms which might remain to the ears for hours together without fatigue. He has constructed telephones weighing only 50 grammes (against 400 grammes of the ordinary type), and of 1in. to 1¼in. diameter. Two of these are connected by a steel magnetic spring passing under the chin, and are pressed closely to the earhole. The steel spring serves also as electric connection for two of the contacts, thus acting mechanically, magnetically, and electrically at the same time. He gives his arrangement the name of the "bi-telephone."

Bideford.—At the last meeting of the Bideford Local Board the question of lighting the quay with electricity was brought up. Mr. Dymond considered it high time, now the Board were contemplating the laying out of their quay in an attractive manner, that they should have it lighted in the best manner possible. He enquired whether it would not be possible to have the whole of it lighted with the electric light. It was now in general use elsewhere, and as electricity was bound to come into use at Bideford the

Board should take it into consideration, and see if they could not arrange with the local firm who had already introduced it in Bideford to light the Bideford New Quay.

Colonial Enterprise.—Mr. J. F. Albright, managing director of Crompton and Co., Limited, has just returned after a very successful tour round the world. He started originally with the Iron and Steel Institute for the United States, and then went to Australia to look after the business of the Crompton Electric Supply Company of Australia. After spending some months in various parts of Australia, he went to Ceylon, and from thence to Calcutta. After this he proceeded to Colombo and Mauritius, *en route* for Durban. Making this his headquarters, he went up country to Pretoria, where his company is about to carry out the lighting of the town. We are glad to learn that the change has done him much good.

Permanent Exhibition.—We notice that for some time back there has been established in Paris, in the Passage Jouffroy, a permanent exhibition of electrical appliances, compressed air electric lighting motors, and similar useful facilities of modern civilisation. We should think it might be very well worth while for a few of the larger firms to institute in London, on a modest scale, an exhibition of this nature, with rooms fitted up in every way with electric lighting, heaters, and cookers, with motors applied, and so forth, advertised well in the daily press. The number of people even now who do not realise the benefits of electricity, and do not understand the very rudiments, is still enormous.

Staple Driver.—An extremely simple and cheap, and at the same time effective, little device has been introduced by Messrs. Woodhouse and Rawson in the shape of a patent staple driver for electric or other wires. This tool holds the staple in position until it has penetrated sufficiently far to dispense with further support, and can be driven home with a hammer. It consists of a rectangular tube of the size to hold the staple, inside being a plunger with a movement of about ½in. The points of the staple project, and are placed over the wire, and a blow is given to the opposite end of the plunger, the tool is removed and the staple driven home. It will be especially convenient to the electrical trade for running wires overhead or in corners where the staple cannot be held with the fingers.

Austrian Telephones. — The concession granted several years ago to the Telephone Company of Austria for opening telephone exchanges in the towns of Gratz, Prague, and Trieste will expire in October this year, and the concession for five other towns, Lemberg, Reichenberg, Pilsen, Czernowitz, and Bielitz, held by the same company, will terminate in February, 1893. The company, which is an English one, has received notice that the concessions will not be renewed, and that the exchanges in all the towns mentioned will be worked by the Imperial Postal Department. It has accordingly demanded compensation to the extent of 1,900,000 florins, or about £160,000 sterling, but the Government object to the amount as exorbitant. The dispute will probably be settled by arbitration, as provided in the terms of the concession.

Andes Railway.—The tunnels of the wonderful railway now in course of construction through the Andes for the purpose of establishing communication between the Argentines and Chili are being bored, it appears, by the aid of the electric current. The highest of the tunnels is about 10,000ft. above sea-level, while the pierced mountain is about 12,000ft. From Juncal, in Chili, to Quebeda Navaro, in the Argentines—a distance of about 14 miles—there are, it is stated, no fewer than eight tunnels, of a total length of nearly 9½ miles. It having been found impracticable to employ steam engines from the great expense of raising machines and fuel to so great an altitude, it was decided to utilise the water power available in the valley for supplying the necessary power; and the great turbines are reported to be doing their work well.

The Paris Metropolitan Railway.—The Paris Municipal Council on Saturday continued the debate on the subject of the proposed metropolitan railway, and heard the evidence of the director of the works, and M. Sauton, the reporter, the latter explaining the views of M. Guyot as regards the rights of the Council in the matter. The Council, without deciding at this stage for any of the schemes before them, declared themselves generally in favour of the construction of a metropolitan railway. A clause in the first article dealing with the course to be followed by the railway was adopted, and a motion introduced by Charles Laurent that the line should in no case follow the boulevards, was also passed by 34 votes against 23. The whole of the first article was then agreed to without amendment, and finally the project was adopted by 60 votes against nine.

Hospital Music by Telephone.—The Rev. Frederick Harford, M.A., minor canon of Westminster, has formed a "Guild of St. Cecilia" for the distribution gratuitously of soft and sweet music for hospital patients. Canon Harford is a great enthusiast upon the well-known soothing effect of dreamy music upon sick persons, variously applied since the time of King Saul, and is organising his guild for the purpose of systematically using music as a healing medicament. His proposal is partly to organise bands of violin performers (with muted violins) and portable "pianino" to perform outside the wards, but he has now extended his idea to include the establishment of a complete system of telephonic distribution from a central hall to the various hospitals. Canon Harford has himself written much suitable music, and already enlisted the sympathy of some influential persons in favour of his scheme.

Gas v. Electric Light in New York.—For 40 years prior to the introduction of electricity for lighting purposes in New York City, the increase in the consumption of gas, says a gas journal, averaged about 10 per cent. per annum, while the population doubled every 17 years. Since the adoption of the electric light, however, the increase has been much more rapid. It almost immediately rose to 12 per cent. per annum, and in 1887 it was equal to about 14 per cent. per annum. This ratio was still further exceeded in 1888-9-90. The output of gas in New York is doubling itself now in a period of 6½ years instead of 10 years. The president of the Standard Gas Company thinks that one reason for this very rapid increase is the fact that the electric light has educated the human eye to require more light, and that people are not satisfied with the quantity they formerly regarded as sufficient.

Contracts.—The following are mentioned as likely contracts for the application of electric light: New hospital at Bradford—J. B. Bailey, architect; Dalton-in-Furness, Co-operative Society premises—J. McIntosh, architect, Barrow; Corn Exchange, Gainsborough—D. Macdonald, borough engineer; Weights and Measures Offices, Leeds—borough engineer, Leeds; Bank at Maryborough (Ireland)—J. O'Callaghan, architect, 16, Nassau-street, Dublin; Workhouse at Newcastle; Academy at Stonehaven for Dunottar Educational Trust; Grammar School, Wakefield, apply headmaster; Court House, Cork—Court House Joint Committee, Cork; Library Buildings, Southampton—(W. Henman, architect), apply librarian, Public Library, Southampton; new Municipal Buildings, Oxford—Mr. Bickerton, town clerk, Oxford; Public Library, Brechin, Scotland—architect, J. M. Fairley, 122, George-street, Edinburgh; Police Station, Glasgow—

J. Lang, clerk, City Chambers, Glasgow; Infirmary, Tadcaster—J. A. Bromet, clerk; Arcade at Torquay—J. Watson, architect; Sleight's Hall, Whitby—Clark and Moscrop, architects, Feethams, Darlington.

Maidstone.—At a meeting of the Maidstone Local Board on Tuesday the sub-committee on electric lighting reported a long conference with the manager of the Electric Installation Company, when they ascertained that if the Local Board obtain a provisional order they will experience great difficulty in getting any electric company to take a transfer thereof; that the cost of the smallest installation would be £3 a light, for 5,000 lights, and that if the company carried out the lighting of Maidstone the Board would have the power to purchase the undertaking at any time at a sum yielding 5 per cent. on the outlay. The committee viewed the company's works at Chelsea, which were no doubt as good as any existing at the present time. Councillor Barker urged the appointment of a committee to discuss the question of working the electric lighting themselves or not. He believed it would pay to do their own work. The clerk said they must decide on this course before October 1, or they would again be too late to obtain a provisional order. It was then resolved to appoint a committee to report further on the matter.

Nomenclature.—The German nation are very retrospectively conservative, and strive to make all their terms thoroughly Teutonic and simple. The telephone has been known as the "Fernsprecher,' or far speaker, and now we notice that the telegraph is being termed, in business circulars of Morse telegraph instruments, the "Farbschreiber." In this case the terms are well known, and little good could result from altering them, but in many cases the homely straightforwardness of the German technical terms is really an aid to learners, and the feeling of desire for directness is not one to be despised. Nothing in electrical matters so bothers and frightens the student and the average engineer than those terms, incomprehensible at sight, such as electro-kinetics, hysteresis, and so forth, and even electromotive force, while electric pressure, resistance, lag, dip, etc., almost carry their own explanation. The simplification of scientific nomenclature, as against what might be termed, in imitative verbosity, its "augmented nebulosity," is a matter that deserves constant and serious attention from those who are in the seats of learning as well as from engineers.

Sevenoaks.—At a meeting of the Sevenoaks Local Board on Monday, 27th July, a letter was received from the secretary of the Electric Trust, Limited, referring to the extension of time for executing works under the Sevenoaks Electric Lighting Provisional Order, obtained by them last year, and stating that they had applied to the Board of Trade for an extension of the order for 12 months on the ground that they were in communication with the clerk and surveyor to the Local Board. The clerk (Mr. H. J. Thompson) said that the latter part of the letter was not strictly correct, as no communication had been received from the trust, who, under their order, were bound to commence the work within 12 months, but had not done so. The surveyor said if the Board acceded to the application of the trust, they would be giving them a monopoly which might turn out detrimental to the district. The Rev. J. Jackson said the surveyor was too late to urge opposition. The Board had decided last year not to oppose the order, and it was not now sought to alter the order, but to extend the time. The surveyor said the Board was not bound to do so. The clerk said any resolution of the Board would influence the Board of Trade, but ultimately it was decided to await a communication from the Board of Trade before passing any resolution.

Munich.—The Municipality of Munich has decided to erect a central electric light station, and has commissioned Herr Oscar von Miller to prepare a scheme. The report of Herr von Miller states that the motive power, to the extent of 2,250 h.p., will be available from the falls of the Isar. Four turbines will drive as many dynamos. The lighting of the streets will be carried out by 307 arc lamps, distributed over a circuit of about five miles. The Town Hall, municipal buildings, post office, museum, docks, and other public buildings will take some 6,000 lamps. Motive power will also be distributed. The following is the estimate of the first cost:

Hydraulic construction	1,200,000	marks.
Foundations, etc., for engines	380,000	,,
Turbines and races, and erection	353,000	,,
Engines and boilers, and erection	175,000	,,
Dynamos and electric apparatus	264,000	,,
Mains	1,028,000	,,
Total (say, £170,000)	3,400,000	marks.

The cost of running, including interest on capital and depreciation, are given at 600,000 marks. The lamp-hour of 16 c.p. will bring 1·4 pfennig (·17d.), and the lamp-hour per arc will be 14·1 pfennig (or 1·7d.).

London County Council.—The Highways Committee at last meeting reported that they had considered a notice, dated 21st July, 1891, from the Metropolitan Electric Supply Company, of intention to lay mains in Amberley-road and Bloomfield-street, Paddington. The proposed works are similar to those of this company which the Council has approved on previous notices, and they recommend that the sanction of the Council be given to the works referred to in the notice upon condition that the company do give two days' notice to the Council's chief engineer before commencing the works; that the mains be enclosed in iron pipes or efficient casing, and be laid under the footways wherever it is found practicable to do so; that, as an additional precaution against accident through defective insulation of the mains, each of the street boxes shall be provided with an inner as well as an outer cover, the two insulated from each other as far as practicable; and that the outer cover, which shall consist of an iron frame filled in with material to suit the paving, shall be efficiently connected to earth. They also have to report the receipt of a notice, given in accordance with the decision of the Council to accept four days' (instead of one month's) notice, in respect of the laying of service line from mains already laid from the Electricity Supply Corporation to supply No. 37, Strand.

Iron and Steel.—Engineers of every kind have nowadays to face the problems of the utilisation of iron and steel in nearly every department of their constructive work, and to those who experience does not lie amongst the actual foundry and forging practice, a book such as that we have before us should be invaluable. Its title explains itself—"Economics of Iron and Steel—being an attempt to make clear the best everyday practice in the heavy iron and steel trades to those whose province it is to deal with the material after it is made," by H. J. Skelton (illustrated; Biggs and Co., 5s.). Mr. Skelton traces from the iron ore the manufacture of pig iron, explaining the varieties of ore and of pig, and the qualities of the best kinds and brands of cast and wrought iron. Particular attention is everywhere given to the description of the most usual processes and sections, so that customers ordering may know what are the most easily obtainable sizes. The actual methods of best modern practice are described at some length, and the work is illustrated not only with sections and details of pig, angle, tee, and other iron bars, but with many photographic reproductions of actual works taken from the Ebbw Vale, the Lilleshall, and the Steel Company of Scotland works. The chapters on steel are equally practical; the methods of manufacture are described and compared, and the applications dealt with. Great attention is paid to the question of testing both iron and steel, and much information not otherwise easily attainable is given, as Mr. Skelton has at command full particulars from a large trade experience of the manufacturers', Admiralty, and Board of Trade tests. The work concludes with a score of pages giving a very complete list of the trade sizes of rolled iron and steel, with comparative prices and remarks, and altogether makes one of the most useful books of reference that an engineer could place in his library.

Egremont.—The last monthly meeting of the Egremont Local Board had before them the question of electric light. It being stated that the gas rate would be 4s. per 1,000 cubic feet, a letter was read from Messrs. Nicholson and Jennings stating that the cost of a complete light installation, excepting motive power and house, would be £1,972. 10s. They also asked for information as to the River Eden with a view to it being utilised as motive power. The chairman said it appeared the outlay in adapting the electric light would be very expensive. The clerk said Messrs. Nicholson and Jennings originally fixed the cost at £3,000, but if water were going to be used as the motive power they had reduced it to £1,972. The surveyor stated the gas came to about £300 a year. The gas costs about £200, besides the cost of other work. The view was expressed that there would not be enough water in the river during the summer months. The chairman referred to the installation at Keswick. Mr. Smith stated there was plenty of fall and power—any amount. The chairman thought they ought to be sure of having it all the year round if the public were to have the benefit of it in private houses. Mr. Armstrong thought the tender a remarkably small one. They could borrow £2,000 at 4 per cent. It might be too late in the year to entertain it now; but if the gas company did not give them better terms another year it should be seriously considered. Mr. Stout said there was not the slightest doubt but that they were paying far too much for the gas. Whitehaven had it at 3s. 2d., and the only difference in producing it at Egremont would be the carriage of coal. The chairman said the gas company had laid out a lot of money in putting down the pipes. He did not think they could let them have gas much cheaper. After further discussion, the surveyor was instructed to report upon the subject at the next meeting, and it was agreed to supply the information asked for by Messrs. Nicholson and Jennings.

British Association.—The president-elect of the Cardiff meeting is Dr. William Huggins, F.R.S., one of the most eminent astronomers living, whose spectroscopic researches on the celestial bodies have yielded the most brilliant results. It is probable, then, that Dr. Huggins's presidential address will deal mainly with the work of his life, and he may be expected to review briefly the results which have been achieved by the application of spectroscopic photography to the heavenly bodies. From the president, Prof. O. J. Lodge, F.R.S., of Section A (Mathematics and Physics), something at least original, if not startling, may be expected. It is understood that he proposes to advocate the establishment of a permanent Government physical laboratory on the lines of the Greenwich Observatory to be devoted to physics instead of astronomy; taking up the more serious quantitative determinations, and the observation of molecular changes in the properties of materials. It is proposed to hold in Section A, if possible, in conjunction with Section G, a discussion on "Units and their Nomenclature," having special regard to the new electrical and magnetic units now becoming necessary for practical purposes. The president of Section G (Mechanical Science) is Mr. T. Forster Brown, the well-known engineer, and his address will deal chiefly with mechanical appliances associated with coal mining, and specially with reference to South Wales. The address will have reference to the application of compressed air to mining purposes, electricity in mining operations, and to modern improvements in shipping coal. The following are among papers which have been promised for this section: Messrs. P. W. Willans and M. Robinson, on the Willans engine; Mr. W. Robinson, on a petroleum engine; Mr. E. Vernon, on the Bénier hot-air motor; Mr. R. H. Thorpe, on the Otis electric elevator; Mr. W. H. Preece, on the London and Paris telephone; Mr. A. R. Bennett, on the telephone of the future; Mr. S. Walker, on colliery lamps; Mr. T. Timmis, on electric lighting of trains; Mr. J. E. H. Gordon, on sub-stations.

Telegraphing Across Indian Rivers.—Of several telegraphic lines running from Calcutta to differents parts of India, there are five proceeding almost due east, three of which convey the Burmese traffic, and the other two the Dacca, Chittagong, and neighbouring traffic The country through which these lines pass is intersected by wide rivers, in which connecting cables are submerged. For instance, the Pudda river, which is seven miles broad near Calcutta, is cabled at two points 12 miles apart; and it often happens that these cables break down while the river is in flood, so that repairs are difficult or dangerous, and a boat service to convey the messages from bank to bank, though practicable, is costly and slow. For some time past, therefore, it has been the practice in such a case to telegraph the message by means of Major Cardew's vibrating sounder through the iron sheathing of the cable instead of the interrupted copper conductor. This innovation is due, says the *Times*, to Mr. W. F. Melhuish, of the Indian telegraph service. Two methods are followed, both of which are quite successful. Either a complete metallic circuit, or "loop," as it is called, is formed by two land lines and two cables, the earth being excluded, or a simple circuit is made of one land line and the broken cable, with the earth as a return wire in the ordinary way. In the latter case, notwithstanding the fact that the iron wire of the cable which form the make-shift conductor are in contact with the water for seven miles across the river, the signals of the Cardew sounder can be read with ease, even when the apparatus is 4in. from the ear. This instrument, which has already been described in our columns, was also tried on the copper conductor of a cable which was completely severed, and the signals managed to pass, either by induction across the break or through the surrounding insulator. It is admirably adapted for telegraph signalling in wild countries or with an army in the field, and, as Indian telegraphists say, "it will work through anything." The method in question has enabled the Indian Telegraph Department to dispose of the local traffic and keep the Burmese lines free for their legitimate business. While upon this subject, we may add that Mr. P. V. Luke, C.I.E., director of telegraphs, Calcutta, is now in England arranging for stores and apparatus to be sent to India, and has contrived a very handy portable field telephone station, consisting of a strong teak box containing a combined receiver and transmitter made in one piece and held by the hand for speaking and listening, together with a call-bell, switch, and two cells of a dry battery. The box is of small dimensions and easily carried in one hand.

THE ORIGINAL ROTARY-CURRENT DYNAMO OF HASELWANDER, AND THE PRIORITY IN THE INVENTION OF THE ROTARY-CURRENT SYSTEM.

From a lecture on the rotary-current system delivered by Dr. Epstein, on April 12, 1891, in the Electrotechnical Society of Frankfort, and published in Nos. 32-34, 1891, of the *Elektrotechnischer Anzeiger*, we take the following particulars with reference to Haselwander's original rotary-current dynamo, which was exhibited in the lecture hall, and was explained by the lecturer and by the designer, Herr Haselwander.

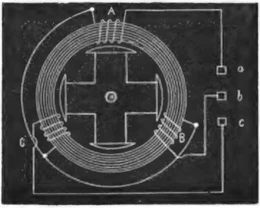

Fig. 1.—Diagram of a Three-Coil Rotary-Current Dynamo.

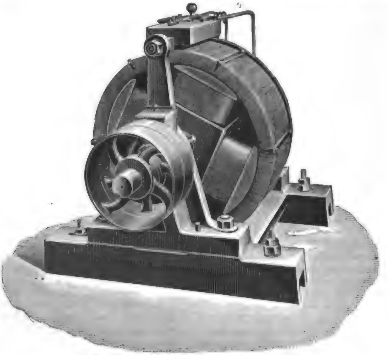

Fig. 3.—Haselwander's Rotary-Current Dynamo of 1887.

This dynamo, represented in the annexed figures, was constructed in the summer of 1887, and first set to work on [illegible] October [illegible] same year. It has a four-pole fi[illegible] interior of a stationary ring a[illegible] with [illegible] of wire, d[illegible] are gr[illegible] by 120[illegible] sets are connected together, the other ends lead to t three terminals of the dynamo. To enable the connectio to be understood, the annexed diagram represe the arrangement with only three coils, A, B, C a, b, c denote the dynamo terminals. The second diag represents a ring with 12 coils, similar to those of th dynamo. Here the ends of each coil are led to an annu terminal-board at the front of the armature, and there co nected to terminal screws. The connections can be made s as to generate a strong current at a low pressure, or, i versely, a low current at a high pressure. The outp of this machine, calculated in continuous current, is amperes by 110 volts at 960 revolutions. The total weight is 303 kg. (667lb.), the weight of copper 22·2 kg. (49lb.).

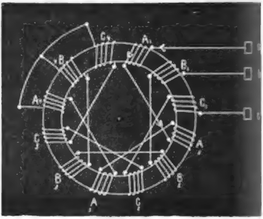

Fig. 2.—Diagram of Connections in Haselwander's Dynam

In the discussion which followed the lecture above mentioned, and in which Herren Haselwander, Lahmeyer, Dolivo-Dobrowolsky, Dr. May, and the lecturer took part, the question of the priority in the invention of the rotary-current system was agitated; as the matter was discussed mainly by persons concerned, a brief historical ccount of this invention might be of some interest and not ithout use for a due appreciation of the relative merits of ach inventor.

The first idea of a rotary-field motor belongs to Prof. alileo Ferraris, who made his experiments relative thereto n the autumn of 1885, and on March 28, 1888, delivered a eport upon his system in the *R. Accademia delle Scienze di orino;* his paper was published in the *Transactions* of that cademy in the same year. By combining two separate quiperiodical alternate currents differing by 90deg. in their hase, he generates in a stationary four-pole field magnet rotating field which drives a massive or closed-coil armature. He obtains the two working divergent currents from a ingle alternate current in the following ways: (1) By oubling the original alternate current with its secondary urrent produced in a transformer; (2) by splitting the riginal or the secondary alternate current in two branches, ne of which is suitably retarded in its phase by means f self-induction; (3) by combining two divergent-phase econdary currents produced by the original in two different ransformers, or in a single transformer specially designed or this purpose.

On May 18, 1888, Tesla, in America, reported upon his otary-field system; the two alternate currents differing by 0deg. he employed for driving a rotary-field motor were generated directly by means of a Gramme armature dynamo and transmitted to the motor by means of four ingle wires, which number was subsequently reduced to hree.

In the summer of 1887 Haselwander, in Germany, designed a four-pole rotary-current dynamo generating a complex current of three currents displaced by 120deg. in their phase, and transmitted by means of three single wires; he employed in his dynamo the so-called open interlinking. On July 21, 1888, Haselwander applied for a German patent, the specification of which, sealed under the same date, on account of some formalities had to be renewed, was accepted in 1880 and published in June, 1890.

On May 9, 1887, Bradley applied for an American patent, the specification of which was published on the 2nd of October, 1888. In this patent he describes the generation of two alternate currents, differing by 90deg. in their phase by means of an ordinary Gramme armature; the currents are taken off four slide rings and transmitted by means of four single wires. In a subsequent patent, applied for on October 5, 1888, and published on August 20, 1889, Bradley reduces the number of slide rings, and that of conducting wires to three, for generating a three-phase current complex, the single currents of which differ by 120deg. in their phase. He employs the so-called closed interlinking.

From this short sketch we see that Ferraris first conceived and worked out into a system the idea of rotary-field working; Tesla first announced the direct generation of two separate divergent-phase currents, by means of a dynamo for driving rotary-field motors; Haselwander and Bradley are the inventors of the generation of the interlinked three-phase rotary current by means of a dynamo for driving rotary-field motors.

The merits of subsequent inventors consist partly in purely practical perfections, and partly in slight arbitrary modifications of the existing system.

THE DISTRIBUTION OF ELECTRICAL ENERGY.*

BY W. C. RECHNIEWSKI.

The object of this paper is to pass in review the different systems of distributing electrical energy, and to examine in what respects each of them is applicable, taking into account the advantages and disadvantages they present.

The two great systems before us are the continuous-current system and the alternate-current system, each of them comprising a large number of subdivisions. Each is capable of giving a good distribution for electric lighting purposes, and the only reason which renders one or other preferable is the cost of installation and of maintenance.

It is solely from this purely practical point of view that we shall study these systems, commencing by the simplest case of all, that of a small and thickly populated district. Everything points to the use of continuous currents for this case.

CONTINUOUS CURRENTS.

1. *Lighting of a Small District.*—We will suppose 3,500 lamps of 10 c.p. uniformly distributed within a radius of 600 yards around a central station, Fig. 1.

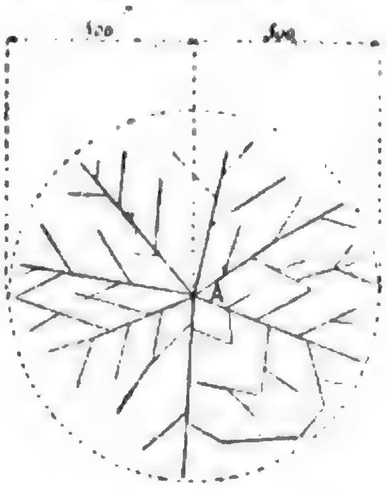

FIG. 1.

We will allow a maximum loss in the mains of 5 per cent. for the lamps that are farthest away, which corresponds to the fall of 5·5 volts in a distributive system of 110 volts. By over-compounding the machines at the central station 2·75 volts, the maximum variation at the lamps will be reduced to 2·75 volts, or 2·5 per cent., which is well within the limits allowed in practice.

Taking the figure of 40 watts per 10-c.p. lamp, the total energy necessary will be 140,000 watts. Two groups of machines of 100 h.p. will therefore suffice, a third being included for safety against accidents.

The following will be the cost of first installation for the central station and mains. (Their equivalents are also given in English money at £40 per 1,000f.)

(*a*) Central station:		f.	£
Sites, buildings, and offices		33,000	(1,320)
Three sets of machines of 100 h.p. (one spare), each including boiler, condensing engine, pipes, belting, etc.	24,000f.		
Dynamos	10,000		
Three sets at	34,000	102,000	(4,080)
Switchboards, instruments, etc.		10,000	(400)
		145,000f.	(£5,800)

(*b*) Mains:

We have allowed a maximum loss in the conductors of 5 per cent.—*i.e.*, 5·5 volts if the normal pressure be 110 volts; this fixes the density of current in the wires for a lamp placed 500 metres (550 yards) away (1,000 metres, or 1,100 yards, return) at 0·4 ampere per square millimetre section (say 260 amperes per square inch).

The total number of amperes is $\frac{3{,}500 \times 40}{110} = 1{,}295$.

The total section of conductor at the entrance to the station will therefore be $\frac{1{,}295}{0{\cdot}4} = 3{,}237{\cdot}5$ mm.^{2} say 32·4 cm.^{2} (or 12 square inches).

The lamps being uniformly distributed around the central station on a radius of 500 metres, the average distance of a lamp from a station will be 333 metres. The total volume of copper will therefore be $2 \times 33{,}300 \times 32{\cdot}4 =$ 2,157,840 cubic centimetres, or 19,280 kilogrammes (42,416lb., or, say, 19 tons), costing at 2½f. per kilo., 48,200f. (£1,928).

It is difficult to estimate the cost of laying mains, as this varies with the distribution of the lamps, the system of mains, whether overhead or underground, the system of insulation employed, etc.; we will take approximately the figure of 20,000f. (£800).

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* Translated from *L'Electricien.*

The mains laid up to the doors of consumers will be, therefore, 68,200f. (£2,728).

The expenditure necessary for an electric lighting company to produce the electricity and lead it to the doors of the houses will therefore be :

	f.	£
Central station..................	145,000	(5,800)
Mains	68,200	(2,728)
	213,200	(8,528)
Working capital, say	36,800	(1,472)
Total capital engaged	250,000f.	£10,000

To estimate the cost of running we should require to know the number of lighting hours per lamp; in other terms, the load diagram of the station. We may in most cases estimate the period of lighting per lamp per day at two hours, which will correspond to about $2 \times 40 \times 3{,}500 = 280{,}000$ watt-hours, or 400 h.p. per day.

The expenses of maintenance may be estimated thus :

	f.	f.	£
1 chief engineer	3,600		
1 assistant engineer	2,400		
2 electrical engine drivers	5,200		
2 stokers	4,200		
Staff, total		15,400	(616)
Coal, 3 kg. (6·6lb.) per horse-power hour = 3 kg. × 400 × 365, or 468 tons at 20f. (16s.)..................	9,360		
Oil, waste, etc........................	3,000		
Fuel, etc., total		12,360	(494)
Interest on a capital of 250,000f. at 5 per cent.	12,500		
Depreciation of buildings and mains at 5 per cent. on 101,200f.	5,060		
Depreciation and repairs to plant 10 per cent. on 112,000f.	11,200	28,760	(1,150)
Total expense of maintenance.....................		56,520f.	(£2,260)

These expenses do not include the charges levied by the local authorities, which will vary from one place to another in a manner impossible to estimate generally.

To sum up, with this system of distribution and with an average duration of lighting of two hours a lamp per day, we have as cost of installation per lamp

$$\frac{50{,}000\text{f.}}{3{,}500} = 71{\cdot}43\text{f. (£2. 17s. 2d.).}$$

$$\text{Annual expenditure} \quad \frac{56{,}520\text{f.}}{3{,}500} = 16{\cdot}15\text{f. (12s. 11d.).}$$

The weight of copper in the mains per lamp will be

$$\frac{19{,}280}{3{,}500} = 5{\cdot}5 \text{ kilog. (12·1lb.).}$$

We would point out here that the central station is capable of supplying current for 3,500 lamps burning simultaneously, which presupposes a much larger number of lamps really installed, as it can never happen that all the lamps of a town are burning at the same time.

We will now consider the manner in which the weight of copper in the conductors increases with the dimensions of the district to be lighted, taking the same density of lighting and the same percentage of loss.

Let us suppose that the linear dimensions of the district increase in the ratio of n to 1. The number of lamps will become n^2 times greater; the density of current in a wire for the same loss will be n times less. The section of mains will thus become n times greater per lamp, that is, in reality n^3 times greater; their length having also increased in the proportion of n to 1, the weight will therefore be n^4 times greater. That is to say, that the weight per lamp of the mains in a system varies as the square of the linear dimensions of the space to be lighted.

Calling w this weight, and r the radius of the space to be lighted, we shall have

$$w = a\, r^2.$$

We have taken r to be 500 metres (550 yards), and w to 5·5 kg. (12·1lb.); whence $a = \dfrac{5{\cdot}5}{250{,}000} = 0{\cdot}000022$; therefore,

$w = 0{\cdot}000022\, r^2$ kg. per lamp (or 0·0000484lb. per lamp).

Thus, for a radius of 1,000 metres, we shall have

$$w = 22 \text{ kg. per lamp (48·4lb.);}$$

and for a radius of 250 metres

$$w = 1{\cdot}375 \text{ kg. per lamp (3lb.).}$$

It is therefore seen that the weight of mains per lamp increases very quickly, and beyond 500 metres radius become onerous.

But we can dispose the system of distribution in such a manner as to diminish this expense, as shown in Fig. 2.

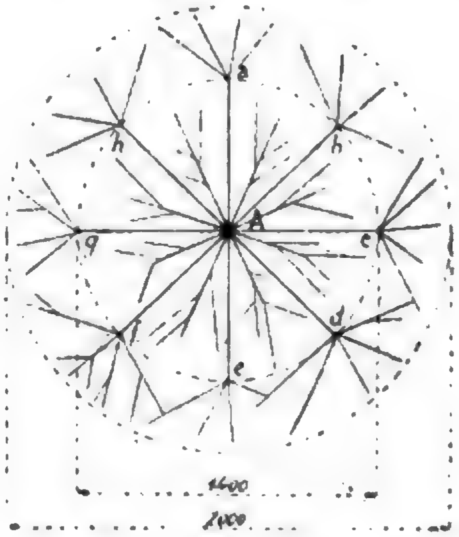


FIG. 2.

We will suppose the lamps distributed within a radius of 1,000 metres from the station. Instead of connecting the lamps directly to the station, they can be joined to secondary centres of distribution, *a, b, c, d, e, f, g, h*, the centres being fed by feeders A *a*, A *b*, . . . A *h*. The advantage of this arrangement consists in the fact that we can allow a greater loss of voltages in the feeders, if only the potential is kept constant, automatically, at the points *a, b, c, ... h*, or even increased by 2·75 per cent. from normal at full charge.

We can thus distribute our lighting in the following manner :

(1) Central district around A of 800 metres diameter.

(2) Eight districts of 300 metres radius arranged around the first. The weight of copper per lamp for the central district will be $w = {\cdot}000022 \times 400^2 = 3{\cdot}5$ kg. (7·7lb.) per lamp; in each of the eight peripheral districts $w = 0{\cdot}000022 \times 300^2 = 1{\cdot}98$ kg. (4·35lb) per lamp.

In the feeders we may lose up to 15 per cent.—*i.e.*, 16·5 volts. Their average length is 700 metres; this determines the density of current to be about 0·6 ampere per square millimetre (400 per square inch).

The current per 10-c.p. lamp being about ·36 ampere, the weight of feeder per lamp will be 7·5 kg. (16·5lb.).

To sum up, we shall have in the central district 2,240 lamps, and $2{,}240 \times 1{\cdot}98 = 4{,}435$ kg. (9,757lb.) of copper in the conductors. In the exterior districts we shall have 11,760 lamps; 11,760 $(3{\cdot}5 \times 7{\cdot}5) = 12{,}936$ kg. (28,459lb.). The total weight of copper in the conductors per lamp will therefore be

$$\frac{12{,}936 + 4{,}435}{14{,}000} = 9{\cdot}5 \text{ kg. (20·9lb.) per lamp.}$$

It is thus seen that we economise $22 - 9{\cdot}5$ kg. $= 12{\cdot}5$ kg. (27·5lb) of copper per lamp by reason of the simpler method of distribution.

But it must not be forgotten that, as we have allowed for a loss of 16·5 volts in the feeders, it will be necessary to have the plant at the station of greater capacity to produce the requisite pressure, and, at the same time, rather more coal will be used. These disadvantages are counterbalanced by the diminution of general cost resulting from the concentration of a plant of greater power at the central station.

Three-Wire System.—By this system, which is too well known to need description here, five-eighths of the weight is economised at the cost of a slight complication. This system is, moreover, applicable as well for a simple distribution as for a distribution by means of feeders.

Instead of leading back to the station the third wire, which serves solely as compensating conductor, we may employ an equalising system of consumption, consisting of two armatures fixed to the same armature, and turning in the same field.

One brush of each armature is connected with the intermediate conductor, while each of the two other brushes communicates with one of the main conductors. It is easily seen that, when the lamps are not absolutely equally distributed on the two circuits, one of the armatures acts to that extent as a motor, and absorbs the current from the circuit which has too few lamps, while the other armature, acting as generator moved by the motor, produces current, and adds it to the circuit which has too many lamps; this effect therefore tends to equalise the current in the two circuits. *Systems of four, five, etc.*, wires can also be easily employed, the intermediary conductors returning to the station.

The lighting district of the Place Clichy, in Paris, is supplied in this manner with five conductors, and with consumption equalisers, to regulate the current in each circuit.

The dimensions of the compensating conductors may vary from zero to a cross-section, equal to that of the outside principal conductors. Taking all the conductors as equal, we find, taking as unity the expenditure in copper for the simple distributive system, the comparative cost to be:

For the three-wire system and 220 volts at the lamps = [illegible]
" four " " 330 " " = [illegible]
" five " " 440 " " = [illegible]

If we allow 10 kg. (22lb.) as the limit of weight of copper to be employed per lamp, we arrive at a radius of:

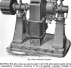
671 metres around the station with the simple parallel system at 110 volts;
1,000 to 1,100 metres with parallel system and ordinary feeders;
1,074 metres with three-wire system;
1,600 to 1,800 metres with three-wire system and feeders;
2,000 to 2,300 metres with five-wire system;
2,300 to 2,500 metres with five-wire system and feeders.

(*To be continued.*)

WILSON HARTNELL DYNAMO.

Mr. Wilson Hartnell, of Volt Works, Leeds, whose name is well known, especially in the North of England, as having carried out some of the largest mill and mansion electric lighting—amongst these Wentworth Castle—has recently taken London offices at 11, Queen Victoria-street, E.C. It may not be yet generally known to our readers that Mr. Hartnell for some little time has been manufacturing his own type of dynamo, and we have recently had the opportunity of inspecting one of the Hartnell dynamos, Nypps, at the London offices.

The dynamo is well represented in the accompanying illustration. It is a compact, well-finished machine, embodying the latest and best practice in dynamo design, and with some special points of interest. The magnets are of specially annealed wrought iron, and the magnetic circuit is of simple section.


The Wilson Hartnell Dynamo.

The exteriors are finished bright, and give the machine a very smart look. The principal feature, however, is the armature, which is very large for the size of machine, being 8¼in. diameter for the N type, which gives 27 amperes at 110 volts for 1,150 revolutions. The spindle is of steel 1⅛in. diameter, and the bearings very long and solid—at the pulley end 6in. long, at the other end 5in. long. They are provided with double oil vessels and oil-rings. The commutator is correspondingly large and solid, being 3in. diameter. This large size makes the machine run very cool and free from sparking, and in practice they show no appreciable wear.

The brushes are arranged on a special carrier, designed by Mr. Hartnell, in which a strong spring is released by a trigger arrangement, and the brushes pressed into position. The same trigger takes off the brushes by an ingenious reverse action.

These dynamos are being manufactured at Volt Works, Leeds, and Mr. Hartnell is ready to supply the trade or colonies. Their qualities for continuous running, high reason of good design and the capacious armature, seems very high. There are several cases in which the dynamos are running continuously without stop, from Monday morning to Saturday night, amongst these being the Wheldale Colliery, Castleford, as well as mills at Wakefield and other places.

Messrs. Fison and Co., of Leeds, whose works were fitted up by Mr. Hartnell, have recently spontaneously stated that "it is a distinct pleasure to go round the mill and see the excellence of the light, the finish of the workmanship, and the evident proof that everything is good of its kind."

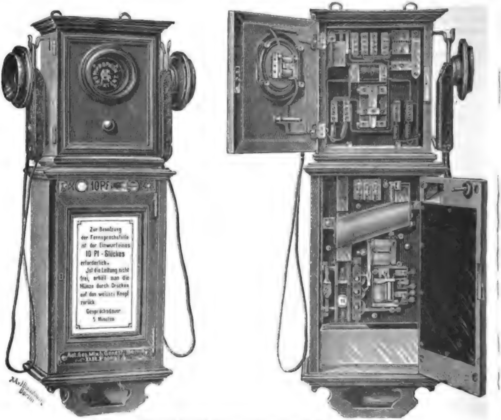
As Irish lighting is now to the fore, it may be mentioned that Mr. Hartnell has recently completed the lighting of a large mill in Cork for Messrs. Furlong and Son, the result of which was so satisfactory that orders were at once received to fit a similar plant for Messrs. Hallinan and Sons, of Fermoy, immediately followed by a second installation for Messrs. Furlong's new mills.

The commercial efficiency of the dynamo is 93 to 94 per cent. in the larger sizes, and it may also be run as a motor, giving an efficiency of about 80 per cent.

THE ABOLITION OF TELEPHONE RENTALS.

The expiry of the Edison patent will, in all probability, mark the commencement of a new era in the development of telephonic communication. With the demand for increased efficiency has also come that for a more equitable system of charging for the use of this convenient and expeditious method of intercourse. At present the same annual rent is required from the subscriber who, perhaps, only uses his instrument once or twice daily as from the stockbroker, whose daily "calls" often amount to hundreds. Again, the provision made for the great body of the non-subscribing public, in the shape of "call-boxes," is, to say the least, neither ample nor easily accessible. Such a state of things, in which the public convenience is cle sacrificed to that of the various companies concerned, i certainly not a common-sense one, and our present purpo is to enquire how it may be remedied, with increas satisfaction and profit to both the general public and t telephone companies.

With regard to subscribers, the system of charg according to the number of conversations naturally presen itself as being perfectly fair in principle, while it does aw with a good many superfluous calls, and thus lightens t labour of the exchange attendants. On the other han however, it may be urged that the increase of cleric labour, rendered imperative by the necessity of keeping a account for each subscriber, more than balances the advantages. Clearly, then, there is but one way in whic the proposed reform can be effected, and that is by th introduction and adoption of a system whereby communication can be obtained from any point of a far-spreading ci



Mix and Genest Automatic Telephone Call-box.

like London, payment being made at the time each conversation takes place, without the customer being subjected t the formality and inconvenience attendant upon the use of the present "call-box."

That the idea of prepayment for each conversation i feasible, is proved by the great success which has attende its adoption by the English Government upon the Londo Paris telephone line. Another argument in its favour i that if properly carried out in the manner indicated above it would completely prevent the frauds to which the telephone companies are at present subject. It is a well known fact, that although telephone subscribers are prohibited from allowing outsiders to use their instruments they are so frequently and persistently pestered by thei non-subscribing friends for "the use of your telephone fo a moment," that they are obliged to give way occasionally and thus the company is defrauded. The adoption of such a scheme as that propounded above would, it is obvious, put a complete stop to this, supposing the principle of "payment before conversation" to be taken as a *sine quâ non.*

As far as we are aware, all efforts made to solve the problem which we are now considering have hitherto resulted in failure; but very recently an apparatus has been patented by the Action Gesellschaft Mix and Genest Company, of Berlin, which they claim, with some show of reason, to fulfil all the conditions necessary for its complete and effectual solution. A short description of the construction and working of the machine, which is described by its inventors as an "automatic call-box," and which is represented in elevation at Fig. 1, and opened to show internal arrangements at Fig. 2, may be interesting.

Upon a coin being inserted into the slot, it first passes through the usual arrangement for testing with regard to diameter, thickness, and weight. Should it fail to pass the test, it is rejected; but if it proves satisfactory, it passes to a pair of grooves, which are movable upon a hinge. Here the progress is arrested by the upper of three wheel segments, which, protruding into the side of the grooves and actuated by the armature of an electromagnet, form a check arrangement. Just before reaching this point, the coin has pressed a small projecting lever, thus making contact and allowing bell to be rung, when the black knob in front of telephone instrument is pressed. The call is answered in the ordinary way from the central exchange, and if the customer is informed that for any reason the required communication cannot be obtained, he has only to press the white stud, when the movable grooves are thrown forward, releasing the coin from the check arrangement, and allowing it to fall to the refunding box.

Should, however, the desired connection be made at the exchange, the current passes through the electromagnet, attracting the armature with a force sufficient to overcome that exerted by its own spring. The coin thereupon falls to the fixed pair of grooves, and is arrested by a segment. Here it remains until the signal at close of conversation is given, when it is again released by the magnet and allowed to fall into the cash-box, pressing en route a second lever which, being connected diagonally with it, replaces same, and at the same time breaks contact. This second lever is of such a length that the coin passing to the refunding box presses it, replacing the first lever and breaking contact as if at close of conversation.

Should, however, the closing signal be omitted, it is obvious that the coin will remain in position. In order to prevent loss from this cause a lever, connected at one end to the armature, and terminated at the other by a small roller, projecting into a slot, is provided. By this means the armature is moved, as if electrically, upon insertion of the next coin, and the one remaining in the instrument has fallen into the cash-box before the other has passed through the testing arrangement.

To sum up the advantages claimed for this instrument:

(1) The exchange can only be rung up upon the insertion of a particular coin, connection being thereupon automatically made for the purpose.

(2) The money is refunded if the desired communication is not to be obtained.

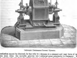
(3) The line is automatically interrupted upon close of conversation.

(4) Absolute security against loss, either on the part of the company or of the customers, no tampering or failure being possible.

The apparatus is now being tested by several European Governments and telephone companies, and after the expiry of the Edison patent it will be shown at the London depôt of Messrs. Mix and Genest, 34, Aldermanbury, E.C., in actual operation.

LAHMEYER DYNAMOS.

We illustrate herewith the continuous-current dynamo of Messrs. Lahmeyer and Co., of Frankfort. The Lahmeyer dynamo is a compact and neat form of machine which has achieved great popularity in Germany. Messrs. Lahmeyer and Co. are also the makers of the Haselwander rotary-current dynamo, an article upon which appears elsewhere. Both machines are exhibited in the Frankfort Exhibition.



Lahmeyer Continuous-Current Dynamo.

TELEPHONE COMPANY OF AUSTRIA.

The eighth ordinary meeting of this Company was held yesterday (Thursday) afternoon at the offices, Mr. Harry [illegible], Chairman, presiding. The report shows a total to credit of profit and loss account of £[illegible], after paying debenture interest and interest on preference shares. In view of the expiration of the Company's concession in October next, and the action of the Austrian Government, the Board do not recommend the payment of a dividend on the ordinary shares at present. With reference to the Company's concession, the Chairman stated that the particulars [illegible] in a daily paper, and given in one of our notes this week, were so accurate they must have been derived from official sources. The Company were ably represented in Vienna by Dr. Eugen Wolzel and Mr. Krause. Some of the Directors had already visited Vienna, and others were about to do so again, to try and secure better and more equitable terms from the Government. The Board had hopes of succeeding in this. The report and accounts were unanimously adopted.

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GOODWILL.

It is an understood thing that balance-sheets are intended to give as little information as possible. There is an item, however, which appears in the balance-sheets of most electrical companies to which exception must be taken. A similar item is not usually to be found in other company work. We refer to the item termed "goodwill." Some time since reference was made to the enormous price standing against "patents" in some of the balance-sheets, and it was argued that by the time a patent had run out its cost should disappear from the balance-sheet. On the other hand, it was admitted that unless the cost was exorbitant it was not altogether necessary to depreciate annually, so that the cost became *nil* at the expiration of the patent. There seems to be a strong argument in favour of "goodwill" in two cases. Firstly, in this case of patents. They are usually bought during a speculative boom in a particular direction, and, owing principally to promoters' charges, at much more than their real value. Then comes the work of the company in developing a business to sell the goods manufactured under these patents. For a term of 14 years the company has a monopoly, though it often obtains it only at a great cost in litigation to stop infringement. Of course we are only discussing successful patents. Our contention is that though the value of the patents should be depreciated annually, so that at the time of expiration their cost in the books of the company stands at nothing, there should be, on the other hand, an equivalent in the annual increase of the value of goodwill. If the patents are duly depreciated, and no equivalent item entered on the other side, the company, at the end of every year, is in a better position than the figures of the balance-sheet show, because it really has an asset as a going concern, the value of which is not shown. But here comes a difficulty. No amount should be put into a balance-sheet that could not be appraised at the figures given by an independent authority. Now, if goodwill is appraised merely as goodwill at the end of every financial year, it must necessarily be a terribly fluctuating item. The second case where goodwill must be considered is when a business is bought as a going concern. Generally a certain amount based upon past annual profits is allowed for "goodwill." This may or may not figure as a separate item in the balance-sheet. In fact, it is usually lumped in the item purchase-money, and as this is expended upon capital account duly appears upon the balance-sheet. It would be surprising, however to find the item "purchase-money" fluctuating in every balance-sheet, as it must do if the value of the "goodwill" is assessed every year.

On the whole, we incline to the opinion that "goodwill" as a separate item is a mistake. In the first case the shareholders can be duly informed that though the patents run out the value of the patents does not run out at the end of fourteen years; and the value should then only be depreciated in the balance-sheet to the normal—that is, to the value outside of promotion, etc. In the second case the value is a constant appearing as purchase-money in the concern. If this is not done unfriendly critics may insinuate that the balance-sheet is cooked, and does not show the real state of affairs. A few thousands more or less put to goodwill makes a good or a bad show.

HARD TO PLEASE.

Who is there that has not heard the tale of the man, the boy, and the donkey? First the passers-by laughed at the man for leading the donkey, the boy walking behind. Why was the poor boy to walk with an animal well able to carry him? The boy was put upon the donkey. Then the passers-by reviled at the boy for riding while the old man walked. Then the man got on the donkey with the boy. The passers-by then reviled them for their cruelty in overloading an animal they were more fit to carry than it was to carry them. To please these critics, the man and boy got off, and proceeded to carry the donkey, which in its struggles to get free fell over the parapet of the bridge they were crossing, and so was drowned. Result, no one was pleased. Very much the same sort of criticism goes on now about everything in general, and electric lighting in particular. The state of the law is such that it is best for supply companies to obtain provisional orders. One important question is whether it is better for the company that its shareholders should be local men interested, both as shareholders and users, in local concerns, or outsiders merely investing in what they may deem a good thing. We hold and have always held that where local men hold the shares, the task of introduction is less arduous, and the prospects of ultimate success much greater. Of course where the local authorities procure a provisional order, outside energy is somewhat at a discount. The wisdom of the critics is shown in that when a local authority starts upon the work, it is told the proper course to pursue is to support a provisional order; if the local authority, instead of getting an order, support some enterprising promoter it is still wrong; if, as in the case of Dover, the authority starts for itself, and then repents, and asks for outside tenders, it is still wrong. The Brush Company very naturally, when the Dover authorities stood aside, proposed to form a local company, but this proposal has met with severe criticism. It is said that tenders for electric lighting are like tenders for printing, and that the Town Council would not support an outsider in forming a local company if printing tenders were in question. There seems, in the critic's mind, to be no difference between an expenditure of fifty pounds and one of fifty thousand—in an expenditure for a purely ephemeral purpose, and one that permanently concerns the town. We are told that if a local company had made a proposal, the Town Council were quite ready to entertain it. There was only one objection to this—the local company is not in existence. Surely the next best thing, according to the critic's own contention, is to support the formation of a local company. It seems to us that the aim of the supply and manufacturing companies to assist in the formation of local companies is a good one. They are far different to ordinary promoters. They do not look to promotion-money, or the financial expedients of company-mongers to recoup them for their time and trouble. They imagine that if an active part is taken in the formation and a smaller or larger pecuniary risk, the contract for supplying the necessary apparatus, and for doing the necessary work, will come to them. A local company would have to go to someone for skilled advice, for apparatus, and for material, and why not from the first be under the guidance of a well-known firm? There is no pleasing everybody. Try then in each case to determine the best course, and stick to it.

THE ACCIDENT ON THE ELECTRIC RAILWAY.

It is to be hoped that, in order to ensure greater safety to the travelling public, the directors of the City and South London Railway Company will adopt the recommendation of the jury who met on Monday to deliberate upon the death of Mr. T. Allen Partridge. The deceased, on the 23rd inst., alighted from a down train at about 3.45 p.m., at the Oval Station, and attempted to enter a lift in motion. Unhappily, he was carried up a short distance, when he came into contact with the beam, and his head was completely severed, the body falling into the well beneath. Pending the holding of an inquest the remains were removed to the Lambeth Mortuary.

The evidence given at the inquest, which was held at The Spread Eagle, Lambeth-road, on Monday afternoon, brought to light a certain laxity in the working of the lifts at the Oval Station—at least on the afternoon in question. From the statements made by persons who were in the lift at the time, it appears that the inner expansible lattice door was only partly closed, whilst the outer gate was open. The order being given, "Right away," the lift was started, the porter, Mullings, at the same time endeavouring to close the outer gate. In this attempt, however, he was thwarted. The deceased at that moment came up, and on being told that he was too late for that journey, said, "I can do it," or words to that effect. Thereupon, he pushed the porter aside and tried to enter the lift, but stumbling against the bottom edge of the lift he seized hold of the inner iron gate and was carried upwards, with the result already mentioned. The whole evidence pointed to the incident being purely accidental. One part of Mullings's duties, when a down train arrives, is to go down to the curved passage, to call out "This way to the lift," and to follow the last passenger to it. On the occasion in question, Mullings had, as he thought, allowed the last passenger to precede him, and on his arrival at the lift gave the order for the ascent. It was then, and only then, that the unfortunate Mr. Partridge came up "like a shadow," as the porter explained, the deceased having probably, as is not infrequently the case, remained on the platform to inspect the line.

On the conclusion of the examination of the witnesses, the room was cleared, and the jury deliberated over the evidence. After about 15 minutes' consideration, a verdict of "accidentally decapitated" was given, and the jury recommended that in future the company should give instructions to have both the doors closed before the lifts were set in motion. The solicitor representing the company said the latter sympathised with the relatives of the deceased, and that the remark of the jury should receive attention.

The company would do well to adopt this recommendation. It would also be wise policy to discontinue the unnecessary hurrying, which occasionally takes place, of passengers from the lifts to the trains, and from the latter to the lifts. The latter is perhaps a matter equal in importance to that of closing both doors.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

TOWNLEY'S ELECTRIC BELL AND DUPLEX ALARM.

SIR,—*Re* Mr. W. R Wynne's patent electric bell, in reply to your correspondents, I wish to state that patent No. 7,373 was not overlooked at the time I applied for a patent for my invention. I failed to see at the time that the principle was the same, and do so at present, except that it was to strike the gong with a hammer, which is common to all electric bells. Certainly I must admit it has been attempted to secure a long contact, but in such a manner that, from an ordinary point of view, is very impracticable. Nevertheless, it is very gratifying to me to learn that they have been supplying these bells for some time, but I must admit that I have never seen or heard of them being in the market, and I have had some few pass through my hands since 1885. As for the fewer working parts and more reliable article, I leave that in the hands of your readers.—Yours, etc., JOSEPH TOWNLEY.

877, Old Kent-road, London, S.E., July 27th, 1891.

SIR,—I should have been rather disappointed had my bell and duplex alarm been allowed to pass by unnoticed by your readers. In reply to your correspondent who merely wishes to show that there is no novelty attached to Townley's alarm, I would venture to say that (after the elaborate description he gives of one that he has had in use since 1886) if he would kindly take the trouble to read carefully the description given in your paper, he will find no mention of any unnecessary fittings; but it is distinctly stated that all complicated parts and switches are entirely obviated, and I may say perhaps, for his personal edification, that such is absolutely necessary to meet the demand of the class for whom this alarm is designed. I may add that this alarm has been in use for the past 12 months without hitch of any kind: this alone is a recommendation.—Yours, etc., JOSEPH TOWNLEY.

877, Old Kent-road, London, S.E., July 27, 1891.

EXPERIMENTS WITH ALTERNATE CURRENTS OF VERY HIGH FREQUENCY AND THEIR APPLICATION TO METHODS OF ARTIFICIAL ILLUMINATION.*

BY NIKOLA TESLA.

(Continued from page 83.)

The importance of these elements in an alternate-current circuit is now well known, and, under ordinary conditions, the general rules are applicable. But in an induction coil exceptional conditions prevail. First, the self-induction is of little importance before the arc is established, when it asserts itself; but perhaps never as prominently as in ordinary alternate-current circuits, because capacity is distributed all along the coil, and by reason of the fact that the coil usually discharges through very great resistances; hence the currents are exceptionally small. Secondly, the capacity goes on increasing continually as the potential rises, in consequence of absorption which takes place to a considerable extent. Owing to this there exists no critical relationship between these quantities, and ordinary rules would not seem to be applicable. As the potential is increased either in consequence of the increased frequency or of the increased current through the primary, the amount of the energy stored becomes greater and greater, and the capacity gains more and more in importance. Up to a certain point the capacity is beneficial, but after that it begins to be an enormous drawback. It follows from this that each coil gives the best result with a given frequency and primary current. A very large coil, when operated with currents of very high frequency, may not give as much as ⅛in. spark. By adding capacity to the terminals the condition may be improved, but what the coil really wants is a lower frequency.

When the flaming discharge occurs, the conditions are evidently such that the greatest current is made to flow through the circuit. These conditions may be attained by varying the frequency within wide limits, but the highest frequency at which the flaming arc can still be produced, determines, for a given primary current, the maximum striking distance of the coil. In the flaming discharge the *éclat* effect of the capacity is not perceptible; the rate at which the energy is being stored then just equals the rate at which it can be disposed of through the circuit. This kind of discharge is the severest test for a coil; the break, when it occurs, is of the nature of that in an overcharged Leyden jar. To give a rough approximation I would state that, with an ordinary coil of, say, 10,000 ohms resistance, the most powerful arc would be produced with about 12,000 alternations per second.

When the frequency is increased beyond that rate, the potential, of course, rises, but the striking distance may, nevertheless, diminish, paradoxical as it may seem. As the potential rises the coil attains more and more the properties of a static machine until, finally, one may observe the beautiful phenomenon of the streaming discharge, Fig. 6, which may be produced across the whole length of the coil. At that stage streams begin to issue freely from all points and projections. These streams will also be seen to pass in abundance in the space between the primary and the insulating tube. When the potential is excessively high they will always appear, even if the frequency be low, and even if the primary be surrounded by as much as an inch of wax, hard rubber, glass, or any other insulating substance. This limits greatly the putput of the coil, but I will later show how I have been able to overcome to a considerable extent this disadvantage in the ordinary coil.

Besides the potential, the intensity of the streams depends on the frequency; but if the coil be very large they show themselves, no matter how low the frequencies used. For instance, in a very large coil of a resistance of 67,000 ohms, constructed by me some time ago, they appear with as low as 100 alternations per second and less, the insulation of the secondary being ¾in. of ebonite. When very intense they produce a noise similar to that produced by the charging of a Holtz machine, but much more powerful, and they emit a strong smell of ozone. The lower the frequency, the more apt they are to suddenly injure the coil. With excessively high frequencies they may pass freely without producing any other effect than to heat the insulation slowly and uniformly.

The existence of these streams shows the importance of constructing an expensive coil so as to permit of one's seeing through the tube surrounding the primary, and the latter should be easily exchangeable: or else the space between the primary and secondary should be completely filled up with insulating material so as to exclude all air. The non-observance of this simple rule in the construction of the commercial coils is responsible for the destruction of many an expensive coil.

At the stage when the streaming discharge occurs, or with somewhat higher frequencies, one may, by approaching the terminals considerably and regulating properly the effect of capacity, produce a veritable spray of small silver-white sparks or a bunch of excessively thin silvery threads, Fig. 7, amidst a powerful brush—each spark or thread possibly corresponding to one alternation. This, when produced under proper conditions, is probably the most beautiful discharge, and when an air blast is directed against it, it presents a singular appearance. The spray of sparks, when received through the body, causes some inconvenience, whereas, when the discharge simply streams, nothing at all is likely to be felt if large conducting objects are held in the hands to protect them from receiving small burns.

If the frequency is still more increased, then the coil refuses to give any spark unless at comparatively small distances, and the fifth typical form of discharge may be observed, Fig. 5. The tendency to stream out and dissipate is then so great that when the brush is produced at one terminal no sparking occurs, even if, as I have repeatedly tried, the hand, or any conducting object, is held within the stream; and, what is more singular, the luminous stream is not at all easily deflected by the approach of a conducting body.

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* Lecture delivered before the American Institute of Electrical Engineers at Columbia College, New York, May 20.

At this stage the streams seemingly pass with the greatest freedom through considerable thicknesses of insulators, and it is particularly interesting to study their behaviour. For this purpose it is convenient to connect to the terminals of the coil two metallic spheres which may be placed at any desired distance, Fig. 6. Spheres are preferable to plates, as the discharge can be better observed. By inserting dielectric bodies between the spheres, beautiful discharge phenomena may be observed. If the spheres be quite close and a spark be playing between them, by interposing a thin plate of ebonite between the spheres the spark instantly ceases, and the discharge spreads into an intensely luminous circle several inches in diameter, provided the spheres are sufficiently large. The passage of the streams heats, and after a while softens the rubber so much that two plates may be made to stick together in this manner. If the spheres are so far apart that no spark occurs, even if they are far beyond the striking distance, by inserting a thick plate of glass, the discharge is instantly induced to pass from the spheres to the glass in the form of luminous streams. It appears almost as though these streams pass through the dielectric. In reality this is not the case, as the streams are due to the molecules of the air which are violently agitated in the space between the oppositely charged surfaces of the spheres. When no dielectric other than air is present, the bombardment goes on, but is too weak to be visible. By inserting a dielectric the inductive effect is much increased, and besides, the projected air molecules find an obstacle, and the bombardment becomes so intense that the streams become luminous. If by any mechanical means we could effect such a violent agitation of the molecules we could produce the same phenomenon. A jet of air escaping through a small hole under enormous pressure and striking against an insulating substance, such as glass, may be luminous in the dark, and it might be possible to produce phosphorescence of the glass or other insulators in this manner.

FIG. 6.

FIG. 7.

FIG. 8.

The greater the specific inductive capacity of the interposed dielectric, the more powerful the effect produced. Owing to this, the streams show themselves with excessively high potentials, even if the glass be as much as 1½ in. to 2 in. thick. But besides the heating due to bombardment, some heating goes on undoubtedly in the dielectric, being apparently greater in glass than in ebonite. I attribute this to the greater specific inductive capacity of the glass, in consequence of which, with the same potential difference, a greater amount of energy is taken up in it than in rubber. It is like connecting to a battery a copper and a brass wire of the same dimensions. The copper wire, though a more perfect conductor, would heat more by reason of its taking more current. Thus what is otherwise considered a virtue of the glass is here a defect. Glass usually gives way much quicker than ebonite; when it is heated to a certain degree, the discharge suddenly breaks through at one point, assuming then the ordinary form of an arc.

The heating effect produced by molecular bombardment of the dielectric would, of course, diminish as the pressure of the air is increased, and at enormous pressure it would be negligible, unless the frequency would increase correspondingly.

It will be often observed in these experiments that when the spheres are beyond the striking distance, the approach of a glass plate, for instance, may induce the spark to jump between the spheres. This occurs when the capacity of the spheres is somewhat below the critical value which gives the greatest difference of potential at the terminals of the coil. By approaching a dielectric, the specific inductive capacity of the space between the spheres is increased, producing the same effect as if the capacity of the spheres were increased. The potential at the terminals may then rise so high that the air space is cracked. The experiment is best performed with a dense glass or mica.

Another interesting observation is that a plate of insulating material, when the discharge is passing through it, is strongly attracted by either of the spheres—that is, by the nearer one, this being obviously due to the smaller mechanical effect of the bombardment on that side, and perhaps also to the greater electrification.

From the behaviour of the dielectrics in these experiments we may conclude, that the best insulator for these rapidly alternating currents would be the one possessing the smallest specific inductive capacity, and at the same time one capable of withstanding the greatest differences of potential; and thus two diametrically opposite ways of securing the required insulation are indicated—namely, to use either a perfect vacuum or a gas under great pressure; but the former would be preferable. Unfortunately neither of these two ways is easily carried out in practice.

It is especially interesting to note the behaviour of an excessively high vacuum in these experiments. If a test tube provided with external electrodes, and exhausted to the highest possible degree, be connected to the terminals of the coil, Fig. 10, the electrodes of the tube are instantly brought to a high temperature, and the glass at each end of the tube is rendered intensely phosphorescent, but the middle appears comparatively dark, and for a while remains cool.

When the frequency is so high that the discharge shown in Fig. 5 is observed, considerable dissipation no doubt occurs in the coil. Nevertheless, the coil may be worked for a long time, as the heating is gradual.

In spite of the fact that the difference of potential may be enormous, little is felt when the discharge is passed through the body, provided the hands are armed. This is to some extent due to the higher frequency, but principally to the fact that less energy is available externally, when the difference of potential reaches an enormous value, owing to the circumstance that with the rise of potential, the energy absorbed in the coil increases as the square of the potential. Up to a certain point the energy available externally increases with the rise of potential, then it begins to fall off rapidly. Thus, with the ordinary high-tension induction coil, the curious paradox exists, that while with a given current through the primary the shock might be fatal, with many times that current it might be perfectly harmless, even if the frequency be the same. With high frequencies and excessively high potentials when the terminals are not connected to bodies of some size, practically all the energy supplied to the primary is taken up by the coil. There is no breaking through, no local injury, but all the material, insulating and conducting, is uniformly heated.

To avoid misunderstanding in regard to the physiological effect of alternating currents of very high frequency, I think it necessary to state that, while it is an indisputable fact that they are incomparably less dangerous than currents of low frequencies, yet it should not be thought that they are altogether harmless. What has just been said refers only to currents from an ordinary high-tension induction coil, which currents are necessarily very small; if received directly from a machine or from a secondary of low resistance, they produce more or less powerful effects, and may cause serious injury, especially when used in conjunction with condensers.

The streaming discharge of a high-tension induction coil differs in many respects from that of a powerful static machine. In colour it has neither the violet of the positive, nor the brightness of the negative, static discharge, but lies somewhere between, being, of course, alternatively positive

FIG. 9.

and negative. But since the streaming is more powerful when the point or terminal is electrified positively than when electrified negatively, it follows that the point of the brush is more like the positive, and the root more like the negative, static discharge. In the dark, when the brush is very powerful, the root may appear almost white. The wind produced by the escaping streams, though it may be very strong—often indeed to such a degree that it may be felt quite a distance from the coil—is, nevertheless, considering the quantity of the discharge, smaller than that produced by the positive brush of a static machine, and it affects the flame much less powerfully. From the nature of the phenomenon we can conclude that the higher the frequency, the smaller must, of course, be the wind produced by the streams, and with sufficiently high frequencies no wind at all would be produced at the ordinary atmospheric pressures. With frequencies obtainable by means of a machine, the mechanical effect is sufficiently great to

FIG. 10.

revolve, with considerable speed, large pin-wheels, which in the dark present a beautiful appearance owing to the abundance of the streams, Fig. 11.

In general, most of the experiments usually performed with a static machine can be performed with an induction coil when operated with very rapidly alternating currents. The effects produced, however, are much more striking, being of incomparably greater power. When a small length of ordinary cotton-covered wire, Fig. 12, is attached to one terminal of the coil, the streams issuing from all points of the wire may be so intense as to produce a considerable light effect. When the potentials and frequencies are very high, a wire insulated with guttapercha or rubber and attached to one of the terminals, appears to be covered with a luminous film. A very thin bare wire when attached to a terminal emits powerful streams and vibrates continually to and fro or spins in a circle, producing a singular effect, Fig. 13. Some of these experiments have been described by me in the *Electrical World* (New York) of February 21, 1891.

Another peculiarity of the rapidly alternating discharge of the induction coil is its radically different behaviour with respect to points and rounded surfaces.

If a thick wire, provided with a ball at one end and with a point at the other, be attached to the positive terminal of a static machine, practically all the charge will be lost through the point, on account of the enormously greater tension, dependent on the radius of curvature. But if such a wire is attached to one of the terminals of the induction coil, it will be observed that with very high frequencies streams issue from the ball almost as copiously as from the point, Fig. 14.

It is hardly conceivable that we could produce such a

FIG. 11.

condition to an equal degree in a static machine, for the simple reason, that the tension increases as the square of the density, which in turn is proportional to the radius of curvature; hence, with a steady potential an enormous charge would be required to make streams issue from a polished ball while it is connected with a point. But with an induction coil, the discharge of which alternates with great rapidity, it is different. Here we have to deal with two distinct tendencies. First, there is the tendency to escape which exists in a condition of rest, and which depends on the radius of curvature; second, there is the tendency to dissipate into the surrounding air by condenser action, which depends on the surface. When one of these tendencies is a maximum, the other is at a minimum. At the point the luminous stream is principally due to the air molecules coming bodily in contact with the point; they

FIG. 12.

are attracted and repelled, charged and discharged, and, their atomic charges being thus disturbed, vibrate and emit light waves. At the ball, on the contrary, there is no doubt that the effect is to a great extent produced inductively, the air molecules not necessarily coming in contact with the ball, though they undoubtedly do so. To convince ourselves of this we only need to exalt the condenser action, for instance, by enveloping the ball, at some distance, by a better conductor than the surrounding medium, the conductor being, of course, insulated; or else by surrounding it with a better dielectric and approaching an insulated conductor; in both cases the streams will break forth more copiously. Also, the larger the ball with a given frequency, or the higher the frequency, the more will the ball have the advantage over the point. But, since a certain intensity of action is required to render the streams visible, it is obvious that in the experiment described the ball should not be taken too large.

In consequence of this twofold tendency it is possible to produce by means of points effects identical to those produced by capacity. Thus, for instance, by attaching to one terminal of the coil a small length of soiled wire, presenting many points and offering great facility to escape, the potential of the coil may be raised to the same value as by attaching to the terminal a polished ball of a surface many times greater than that of the wire.

An interesting experiment, showing the effect of the points, may be performed in the following manner: Attach to one of the terminals of the coil a cotton-covered wire about 2ft. in length, and adjust the conditions so that streams issue from the wire. In this experiment the primary coil should be preferably placed so that it extends only about half way into the secondary coil. Now touch the free terminal of the secondary with a conducting object held in the hand, or else connect it to an insulated body of some size. In this manner the potential on the wire may be enormously raised. The effect of this will be to either increase, or to diminish, the streams. If they increase, the wire is too short; if they diminish, it is too long. By adjusting the length of the wire, a point is found where the touching of the other terminal does not at all affect the streams. In this case the rise of potential is exactly counteracted by the drop through the coil. It will be observed that small lengths of wire produce considerable difference in the magnitude and luminosity of the streams. The primary coil is placed sidewise for two reasons: first, to increase the potential at the wire, and, second, to increase the drop through the coil. The sensitiveness is thus augmented.

There is still another and far more striking peculiarity of the brush discharge produced by very rapidly alternating currents. To observe this it is best to replace the usual terminals of the coil by two metal columns insulated with a good thickness of ebonite. It is also well to close all fissures and cracks with wax so that the brushes cannot form anywhere except at the tops of the columns. If the conditions are carefully adjusted—which, of course, must be left to the skill of the experimenter—so that the potential rises to an enormous value, one may produce two powerful brushes several inches long, nearly white at their roots, which in the dark bear a striking resemblance to two flames of a gas escaping under pressure, Fig. 15. But they do not only resemble, they are veritable flames, for they are hot. Certainly they are not as hot as a gas burner, but they would be so if the frequency and the potential would be sufficiently high. Produced with, say, 20,000 alternations per second, the heat is easily perceptible, even if the potential is not excessively high. The heat developed is, of course, due to the impact of the air molecules against the terminals and against each other. As at the ordinary pressures the mean free path is excessively small, it is possible that in spite of the enormous initial speed imparted to each molecule upon coming in contact with the terminal, its progress, by collision with other molecules, is retarded to such an extent that it does not get away far from the terminal, but may strike the same many times in succession. The higher the frequency, the less the molecule is able to get away, and this the more so, as for a given effect the potential required is smaller; and a frequency is conceivable, perhaps even obtainable, at which practically the same molecules would strike the terminal. Under such conditions the exchange of the molecules would be very slow, and the heat produced at, and very near, the terminal would be excessive. But if the frequency would go on increasing constantly, the heat produced would begin to diminish for obvious reasons. In the positive brush of a static machine the exchange of the molecules is very rapid, the stream is constantly of one direction, and there are fewer collisions, hence the heating effect must be very small. Anything that impairs the facility of exchange tends to increase the local heat produced. Thus, if a bulb be held over the terminal of the coil so as to enclose the brush, the air contained in the bulb is very quickly brought to a high temperature. If a glass tube be held over the brush so as to allow the draught to carry the brush upwards, scorching hot air escapes at the top of the tube. Anything held within the brush is of course rapidly heated, and the possibility of using such heating effects suggests itself.

When contemplating this singular phenomenon of the hot brush, we cannot help being convinced that a similar process must take place in the ordinary flame, and it seems strange that after all these centuries past of familiarity with the flame, now, in this era of electric lighting and heating, we are finally led to recognise that since time immemorial we have, after all, always had "electric light and heat" at our disposal. It is also of no little interest to contemplate that we have a possible way of producing—by other than chemical means—a veritable flame, which would give light and heat without any material being consumed, without any chemical process taking place, and to accomplish this, we only need to perfect methods of producing enormous frequencies and potentials. I have no doubt that if the potential could be made to alternate with sufficient rapidity and power, the brush formed at the end of a wire would lose its electrical characteristics and would become flamelike. The flame must be due to electrostatic molecular action.

This phenomena now explains in a manner which can hardly be doubted the frequent accidents occurring in storms. It is well known that objects are often set on fire without the lightning striking them. We shall presently see how this can happen. On a nail in a roof, for instance, or on a projection of any kind, more or less conducting, or rendered so by dampness, a powerful brush may appear. If the lightning strikes somewhere in the neighbourhood, the enormous potential may be made to alternate or fluctuate perhaps many million times a second. The air molecules are violently attracted and repelled, and by their impact produce such a powerful heating effect that a fire is started. It is conceivable that a ship at sea may, in this manner, catch fire at many points at once. When we consider that even with the comparatively low frequencies obtained from a dynamo machine, and with potentials of no more than 100,000 or 200,000 volts, the heating effects are considerable, we may imagine how much more powerful they must be with frequencies and potentials many times greater, and the above explanation seems, to say the least, very probable. Similar explanations may have been suggested, but I am not aware that, up to present, the heating effects of a brush produced by a rapidly alternating potential have been experimentally demonstrated, at least not to such a remarkable degree.

(To be continued.)

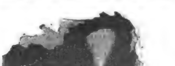
Fig. 13.

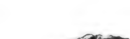
Fig. 14.

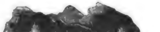
Fig. 15.

CAMBRIDGE.

The following letter has been sent by Dr. Porter to the Local Government Board. It will be seen that it deals with the proposal for electrically lighting the town, and is really an epitomised history of the recent action of the Authority :

Peterhouse Lodge, Cambridge,
July 6, 1891.

Sir,—As a member of the Council of the borough of Cambridge, I beg leave most respectfully to draw your attention to the following statements respecting electric lighting in Cambridge :

1. When Colonel Hasted, representing the Local Government Board, held an enquiry at Cambridge, on March 3, 1891, respecting the application of the Council for leave to borrow £35,000 for the purpose of electric lighting in Cambridge, Dr. Fleming, an electrical engineer of high position and great experience, was the professional adviser of the Council, and the system of electric lighting and ot engine plant and machinery which the Electric Lighting Committee of the Council submitted to Colonel Hasted as that which they proposed to recommend for adoption by the Council was prepared by Dr. Fleming. Dr. Fleming also gave evidence at the enquiry in support of his scheme.

2. On March 9, 1891, the Electric Lighting Committee generally approved the draft contracts with all the firms suggested by Dr. Fleming, and agreed to recommend their acceptance by the Council subject to the consent of the Local Government Board to their application to borrow £35,000. These contracts included the whole cost of the electric installation except that of the station buildings, plans for which Mr. Fawcett, an architect in Cambridge, was instructed to prepare. With reference to the cost of these buildings, the committee state (report, June 3, p. 7) as follows : "On the 17th March the tenders for the erection of the station were opened, when the lowest tender was found to be several thousand pounds above Dr. Fleming's estimate. Under these circumstance the committee felt they were unable to accept any tender, and that it was their duty to reconsider the matter afresh, as it was clear that this large increase in the cost of the building would, even if the other estimates of Dr. Fleming were accurate, entirely do away with the very small margin of profit which he showed in his report, neglecting as he did the cost of the land and the annual instalments for repayment of capital and for interest."

It may be remarked that the statement of the committee that the lowest tender was found to be several thousand pounds above Dr. Fleming's estimate does not seem to be accurate. It appears from Dr. Fleming's report on tenders, section 11, that the estimate for the buildings was made by Mr. Fawcett, not by Dr. Fleming.

3. In pursuance of this resolution a sub-committee of the Electric Lighting Committee visited the works of the Newcastle and District Electric Lighting Company and of the Corporation of Bradford and drew up a report dated 6th April, 1891, which contains a description of the Parsons turbine employed as the motor at Newcastle and of the electric installation at Bradford, where the Willans engine is used. It appears also from the report that at Newcastle upon a capital expenditure of £17,300 a gross profit of £844 for the half-year ended December 31, 1890, was earned by the sale of the electric current at 6d. per B.T.U., no deduction being made for interest on or repayment of capital, or for depreciation of machinery and plant.

If this capital has been borrowed at the rate of 4 per cent. per annum repayable by annuities extending over 30 years, the amount of each half-year's annuity would be about £450, and if 4 per cent. per annum be allowed for depreciation, the amount to be deducted for the half-year under this head would be £346. The net profit for the half-year would thus be reduced to £48 only. With reference to the expenditure on coal, the sub-committee state (report, April 6, 1891, pp. 3-4) as follows : "It seems that the coal consumed for each unit sold was about 23·4lb. and cost 1·133d. This large consumption is due to the fact that the turbines in use at the Newcastle station are of the old type and require a larger expenditure of steam per horse-power than other engines ; and this tells in an especial degree during the hours when the load on the machines is light. In the improved form which the sub-committee saw at Mr. Parsons's works at Heaton the turbines are steam-jacketed, and the admission of steam is made intermittent at less than full load. Those two changes are said to effect a large saving of steam. And when, in addition, the machines are worked with a condenser there will be a saving, according to the estimate of Mr. Parsons, of 35 per cent. at least. If this should prove to be the case, as the sub-committee believe to be likely, the consumption of steam per horse-power in a turbine will be about the same as in a Willans engine of the same power at full load, and probably much less at light load."

It is no disparagement to the committee to say that in this matter they are laymen and not scientific experts, and that no opinion respecting the efficiency and economy of the Parsons turbine can be of any value unless founded upon the direct experiments of a highly-trained mechanical engineer upon the turbine in its improved form. So far as I know, no such experiment has yet been made, although the electric installation at New Scotland Yard, which contains all the improvements in Mr. Parsons's turbine referred to by the sub-committee, has been in use for several months.

The report concludes as follows : "The members of the sub-committee, so far as they are able to judge, are of opinion that the system tendered for by Mr. Parsons should be adopted, subject to there being no fundamental objection on the part of any expert who may be consulted by the Corporation."

This report of the sub-committee was adopted by the committee on April 7, and in accordance with a resolution of the Council was printed and circulated among the members of the Council under date of 20th April. The report is afterwards referred to under this date.

4. The committee submitted this report to Dr. Fleming for his criticisms, and in reply received his report dated April 14, 1891 (report, June 3, 1891, pp. 7-11). In this report, Dr. Fleming states at length the reasons why he is unable to recommend the system of Parsons, and advises the committee not to decide the question at issue without further expert advice.

On the same day on which Dr. Fleming's report was communicated to the committee, a letter, dated April 14, 1891, from Prof. Garnett to Mr. Alderman Finch was also read to the committee (report, June 3, 1891, pp. 11-13). In this letter Prof. Garnett advocates the system of electric lighting which had been carried out by Mr. Parsons at Newcastle-upon-Tyne as well adapted for the requirements of Cambridge.

In consequence of the expression of views adverse to the adoption of the Parsons's system, Dr. Fleming received from the town clerk the following letter, dated April 20, 1891 : "I have been requested by the Electric Lighting Committee to acknowledge the receipt of your report on Mr. Parsons's scheme. In the event of their determining to proceed with the lighting of Cambridge upon the system in force at Newcastle, it would be useless after the opinion expressed in the latter part of your report to expect you to assist the Council in carrying out the work, and the committee are therefore of an opinion that any engagement with you as electrical adviser or expert should cease, and have directed me to communicate their views to and to ask you to send in a statement of your charges with a view to payment."

It is not within the object of this letter to discuss the legality of the action of the committee. I content myself with observing that it was not within the competence of the committee to dismiss an officer whose appointment was communicated to him by the town clerk under date June 24, 1890, in the following terms : "I have to inform you that the terms stated in your letter describing the scope of your duties in regard to electric lighting in this town were approved by the Electric Lighting Committee and on their recommendation have been sanctioned by the Council subject to a slight alteration in paragraph 'B,' which should run thus——."

5. At the meeting of the Council held on May 14, 1891, the Electric Lighting Committee recommended, under date

t May, 1891: "I. That the report of the Electric ghting Sub-Committee dated the 20th April, 1891, and hich has already been printed and circulated, be adopted the Council. II. That in the event of the above report ng carried, Prof. Wm. Garnett, of the Durham College Science, of Newcastle-on-Tyne, be appointed to act as nsulting engineer in carrying out the scheme for lighting e borough with electricity submitted by Mr. Parsons." otwithstanding the concluding statement in the report the sub-committee quoted in section 3 of this letter, e report of Dr. Fleming, the professional adviser the Council, which had been in the hands of the mmittee for nearly a month was withheld from e Council. As I had previously become aware of the istence of this report, and considered it unfair both to r. Fleming and the Council that this document should e withheld from the consideration of the Council, I moved e following resolution, which was adopted by the Council: That the consideration of the report of the Electric ighting Committee, dated the 20th April, 1891, be postoned until the report of Dr. Fleming, dated the 14th April, on he above report of the committee, the report of any expert ho may have been consulted by the committee in accordnce with the resolution of the Council passed at their last eeting, together with all documents or correspondence of public character bearing on the question, have been comunicated to and considered by the Corporation."

6. In accordance with the preceding resolution, the lectric Lighting Committee issued their report, dated une 3, 1891, which was circulated to members of the ouncil on the evening of June 9.

The question of the adoption of the report of the Electric ighting Committee of May 1, 1891, and of an additional ecommendation of the committee dated June 9, 1891—amely, "That in the event of their report of 1st May being dopted by the Council, they be authorised to conclude ontracts for the carrying out of the electric lighting of the own on the general lines of that report, it being undertood that the total cost shall not exceed £26,500, and that he installation shall suffice for 5,000 lights of 16 c.p. or heir equivalent"—came before the Council on June 11, 891, but it was generally felt that sufficient time had not een allowed for the consideration of the report, and the iscussion was adjourned till June 16.

7. It must, I think, be regarded as an unsatisfactory rrangement that the committee who dismissed Dr. leming, because he expressed an opinion adverse to the mployment of the Parsons turbine as the electric motor in ambridge, should without the sanction of the Council ave appointed another expert known to them, from his etter of April 14 to Mr. Alderman Finch, to be in favour f Mr. Parsons's system. For this reason, I cannot regard Prof. Garnett as a neutral expert qualified to decide the oint at issue between Dr. Fleming and the committee. areful consideration of Prof. Garnett's letter and subsequent reports, as given in the report of the committee of June 3, justifies me in stating that his conclusions, like hose of the sub-committee, rest on hypothesis and not on he solid basis of direct experiment on the improved form f turbine.

8. It may be assumed that a corporation would not be justified in undertaking a commercial enterprise such as electric lighting, which could necessarily be beneficial to a limited portion of the community only, without a reasonable prospect of earning a profit in relief of the rates. The value as regards economy in working of the improvements in the Parsons motor is at present only matter of conjecture. Further, when regard is had, on the one hand, to the increased price of 8d. per B.T.U. authorised to be charged in Cambridge as compared with 6d. charged in Newcastle, and, on the other, to the increased price of coals in Cambridge as compared with the price in Newcastle, it is doubtful whether any profit whatever would be earned by the use of the Parsons system, when deductions were made for interest on and payment of capital and for depreciation of machinery and plant.

9. For these reasons, when it was proposed to adopt the recommendations of the Electric Lighting Committee at the adjourned meeting of the Council held on the 16th of June, I moved the following amendment:

"That after careful consideration of the reports of the Electric Lighting Committee of Mr. Parsons and Prof. Garnett in favour of the adoption of the Parsons turbine as a motor for electric lighting in Cambridge, and the report of Dr. Fleming, the professional advisor of the Borough Council, against its adoption, the Council are unable without further professional advice upon the point at issue to adopt the report of the committee.

"That no further expenditure be incurred by the Electric Lighting Committee until a reply has been received to the application of the Council to the Local Government Board to grant leave to borrow £35,000 for the purpose of electric lighting in Cambridge.

"That in the event of the Local Government Board granting the application of the Council, and of the Council determining to proceed with the system of electric lighting, the question at issue between the Electric Lighting Committee and Dr. Fleming as to the efficiency of the Parsons turbine as a motor be referred to Mr. A. B. W. Kennedy, consulting engineer, formerly professor of engineering in University College, London, to report thereon to the Council.

"And that the town clerk be instructed to inform Dr. Fleming that the letter dated April 20, 1891, which the Electric Lighting Committee instructed him to write to Dr. Fleming conveying their resolution to terminate his engagement, was not submitted to, and has not received the sanction of the Council."

The amendment was rejected by the Council, 19 voting against it and 11 in its favour. The recommendations of the committee were then adopted by the Council.

10. In conclusion, I venture to ask that under the changed circumstances of the case since the enquiry was held in March last, the Local Government Board would order a further enquiry into the efficiency and economy of the Parsons system which has now received the sanction of the Council, before giving their consent to the application of the Council to borrow £35,000 for the purpose of electric lighting in Cambridge.—I have the honour to be, Sir, your most obedient servant, JAMES PORTER.

To the Secretary of the Local Government Board.

THE ELECTRIC TRANSMISSION OF POWER.*

BY GISBERT KAPP.

LECTURE II.

(Concluded from page 89.)

Let us now enquire whether we shall be any better off with a shunt-wound motor. The field excitation in such a machine does not depend on the current flowing through the armature as in a series machine, but it is simply the result of the terminal pressure; in other words, whatever current may be required by the armature for giving power, can be, and is, in fact, supplied by the source of current, without in any way affecting the field excitation. If the terminal pressure varies, the excitation and the field strength must also vary; but a variation in the working current will not directly influence the field strength. It will, however, indirectly influence it by reason of a subsidiary effect, technically termed "armature reaction," and this I shall touch upon shortly. For the present we neglect it, and assume that the curve F correctly represent the field strength as a function of the terminal pressure. In machines having wrought-iron magnets, this first part of this curve is almost a straight line, and in this region the field strength is consequently very nearly in direct proportion to the terminal E.M.F. To work the motor at this part of its curve, all we have to do is to supply it with current at a pressure sensibly lower than that for which it is designed. In good machines the resistance of the armature is very low, so that only a few per cent. of the voltage supplied is lost in resistance, even when the maximum current flows through the armature. If, therefore, we work the motor considerably under its power, the armature loss will be almost negligible—that is to say, the counter E.M.F. will be very nearly equal to the supply E.M.F. Now if you look at the formula for E.M.F., you find that on the left you have a value very nearly equal to the supply E.M.F., and on the right you have a constant multiplied with the product—field strength and speed. But the field strength under our special conditions of working is proportional to the supply E.M.F., and as you thus have the supply E.M.F. on both sides of the equation, it cancels out, and you find that the speed, multiplied by a constant, is equal to unity. This of course holds good for any supply E.M.F. within the straight part of the curve; and we find, therefore, that the speed has a definite value which is independent of the supply E.M.F. We have here arrived at a very remarkable result. It is this, that if you work a shunt motor underloaded and at a lower pressure than it is designed for, you may vary this pressure within certain limits without either altering the speed or the power given out.

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* Cantor lectures delivered before the Society of Arts.

As, however, the motor must be large in proportion to its work, the practical use of this remarkable property of shunt motors is limited. What users of these machines want to do is not to get little power out of them, but to get as much power as possible, and, in many cases, more than was intended by the designer. Let us then see how we stand in the matter of speed and power regulation when we work the machine throughout the whole range of output for which it is designed. First, as to speed. Let us assume that the machine is working at a certain speed giving off a definite amount of power, and suppose we wish to increase the speed. How shall we do it? The E.M.F. formula tells us. You see that the field strength and speed occur on the same side of the equation. This means that the one can only be increased at the expense of the other. If we want the machine to run faster, we must weaken its field; if we want it to run slower, we must strengthen it. The variation of field strength is most conveniently brought about by a variable resistance in the magnet circuit. I have such a resistance in the shunt circuit of the machine before you, and can show you, by an experiment, this method of regulating the speed.

In this experiment we have altered both the speed and power, because, by running faster, we have obtained more current from the second machine and a brighter light in the lamp. Let us now see whether it is possible to keep the speed constant, and yet vary the power. Bearing in mind that the dynamo is a reversible machine, and drawing a parallel between a shunt dynamo and a shunt motor, we conclude that there should be no difficulty in doing this. The fact that a shunt motor is an almost self-regulating machine has been first pointed out by Mr. Mordey in an article which appeared in January, 1886, in the *Philosophical Magazine*. Mr. Mordey's reasoning was somewhat as follows: We know that a shunt dynamo will, if driven at a constant speed, give an almost constant terminal pressure, no matter how the current may vary. Consequently a shunt motor, if supplied with current at constant pressure, will run at an almost constant speed, no matter how the load may vary. On testing his theoretical deduction by actual experiment, Mr. Mordey was able to completely verify it. In one set of experiments the supply current was kept at 140 volts, and the load on the motor was varied from 1·8 h.p. to 16·3 h.p., yet the speed only varied by 3 per cent.; and a similar result was obtained with the same machine at a supply pressure of 100 volts. Mr. Mordey stated in his paper that the magnetic distortion of the field was nil, or, as we might also term it, that the armature reaction was negligible. It is, however, easy to see that, even if the armature reaction is sensible, we can yet obtain very fair regulation, provided we take care to have in the armature circuit such a resistance that the voltage loss due to the resistance is about equal to that due to armature reaction.

To explain this, I must first say a few words about armature reaction, a phenomenon which may perhaps not be familiar to all of you. The current flowing through the armature, transforms it into an electromagnet, which, to a certain extent, opposes the flow of magnetic lines emanating from the field magnets. This is the case both in dynamos and motors, though not quite to the same extent. The larger the current, the larger is this opposition which the armature offers to the field magnets; and it is the field strength which remains, after making allowance for this opposing magnetic force, which is productive of E.M.F. To calculate correctly the counter E.M.F. of a shunt motor we must, therefore, not assume the field strength in our E.M.F. equation to be constant, as I have done hitherto; but we must assume that it decreases slightly as the armature current increases. Graphically, this is represented in Fig. 5, where the current flowing through the armature is measured on the horizontal, O C, and the field strength is represented by the inclined full line above. If there were no armature reaction the field strength would be given by the dotted horizontal line. If the speed is to remain constant, the counter E.M.F. must be proportional to the field strength; and, by suitably altering the scale (with which we measure the ordinates in the diagram), we can take the top line to represent counter E.M.F. I have accordingly marked it E E.

The vertical distance, O E, represents now the supply E.M.F., and when the motor is running light, this is, of course, equal to the counter E.M.F. Now, let a load be thrown on, causing a considerable increase of current. The counter E.M.F. need now not be quite so large as before, since part of the supply E.M.F. has been already absorbed by the resistance of the armature circuit, and the counter E.M.F. need only balance the remainder. We find thus that the supply condition of constant voltage requires the counter E.M.F. to become lower as the power demanded from the motor increases. At the same time the working condition of constant speed can only be attained by a lowering of the counter E.M.F. as the current increases; and it is therefore perfectly obvious that if the lowering of the counter E.M.F., as determined by either condition, is the same, we must have constant speed at variable power—that is, a self-regulating motor. Generally, the line E E in the diagram representing counter E.M.F. is not quite straight, but slightly curved, presenting the concave side to the axis of abscissæ, whilst the line representing resistance loss through armature is of course quite straight. If we so design the machine as to get exactly the same speed when running quite light and fully loaded, the speed will be slightly less at half load, but the difference can only be very small. I am able to show you this property of the shunt motor to be almost perfectly self-regulating by means of the apparatus here before you.

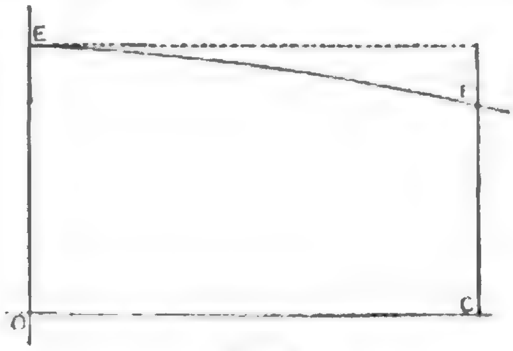


FIG. 5.

Thus, you see that the shunt motor is an excellent machine for keeping the speed constant when worked on a constant-pressure circuit. The only drawback to its employment is that a resistance must be inserted into the armature circuit at starting; but this may be done automatically by placing the resistance permanently in circuit, and causing it to be short-circuited by means of a centrifugal regulator fixed to the armature shaft, and so arranged that when the speed has attained a certain value the balls fly out and close a switch. Such an automatic device is also of value in case the motor should be overloaded. If this should happen the speed will drop, and the resistance will be automatically reinserted, keeping the current within safe limits. By these means a customer of an electric light company is prevented from taking from the mains more current than he has contracted for.

Before leaving the subject of speed regulation on constant-pressure circuits, I must briefly allude to a system in use on electric tramways. Motors for tramcars are not required to run at a constant speed, but they are required to have a wide range of torque. At starting, or when running up hill, the speed may be low, but the static effort must be great. These motors are therefore generally series wound, and provision is made by means of a compound switch for inserting a larger or smaller number of field-magnet coils, so as to vary the field strength according to requirements. The arrangement of the motors under the floor of the car is shown in the diagrams on the wall, which represent respectively the cars of Mr. Reckenzaun, the Electric Engineering Company, and the General Electric Power and Traction Company, but time will not permit of my going into details of the various designs.

When current is supplied to the motor not from a general system of mains, but from a special generator, serving no other purpose, the regulation of speed and power can be effected equally well by series, compound, or shunt machines. As regards the latter, I need not go into details, as this case is really included in the case of supply at constant pressure, which I have already fully treated. After what I have said about this case, you will also readily see that compound-wound motors with the main coils demagnetising are equivalent to shunt motors with large armature reaction, and that, in fact, a shunt motor with very small armature reaction—such, for instance, as a multipolar machine—may be made self-regulating by the addition of demagnetising main coils on the field magnets. I shall later on give you details of a large transmission plant carried out on these lines, and need therefore not go further into the subject now. There remains then only the plain series motor to be considered.

In this case both the generating and the receiving dynamo are series wound, and it is easy to see that by suitably designing these machines we can bring it about that the motor will run at a constant speed under varying loads if the generator is kept running at a constant speed at all times. Let the two curves in Fig. 6 represent the E.M.F. characteristics of the two machines, the upper curve referring to the generator and the lower to the motor. These curves give the useful E.M.F. after deducting armature reaction, and refer of course to constant speed in each case. The current flowing through the circuit is that which we obtain by dividing the difference between the rdinates of the two curves by the total resistance. The resistnce is of course a constant, and the curve representing current nd difference of E.M.F. is therefore a straight line, O R in the liagram. The vertical length, C R, gives the voltage loss with current, O C, due to resistance, and this must be equal to the oltage difference, 1, 2, between the curves. This determines, herefore, the speed of the motor for that particular current. Suppose the lower curve is the E.M.F. characteristic or that particular speed. Now let us throw some of the oad off, then the current will assume a smaller value, say O C'. The voltage loss is now C' R', and the voltage difference 1' 2'. f the E.M.F. characteristic fits this new working condition, hen 1' 2' must be equal to C' R', and the speed will remain the ame as before. We thus find that if we so design the nachines that the difference between their E.M.F. characeristics at any working point is equal to the voltage loss by esistance, we obtain a perfectly self-regulating system of power ransmission. Most of the transmissions now at work have been lesigned by taking advantage of this very valuable quality of eries machines, but I must state at once that, in actual practice, he case is not quite so simple as I have here represented it. One of the difficulties met with is that we cannot always get he two characteristics to fit each other exactly over the whole ange of output; another difficulty arises from their being generally a slight difference between the ascending and lescending characteristics; but the most serious obstacle o quick and perfect regulation is the self-induction of the field magnets, especially if the machines are arge. The self-induction prevents the rapid response of me machine to the other, which is required to make the egulation absolutely perfect. A sudden change of load cannot be followed immediately by a corresponding change in the power supplied to the motor, as time is required by the magnets o settle down into the new working condition; and during the ransitory period, which may last many seconds, there is a urging of power to and fro which creates fluctuation of speed. To mitigate this evil, Herr Dobrovolsky, of the Berlin Electric Company, has devised a plan by which a kind of electrical lamper is applied to the generator in the shape of a nonnductive high resistance placed across the terminals of the nagnet coils as a shunt, and left there permanently. Any bnormal wave of E.M.F. which might otherwise disturb the vorking of the motor or endanger the insulation of either nachine, spends itself in heating this resistance, and the disurbance quickly subsides.

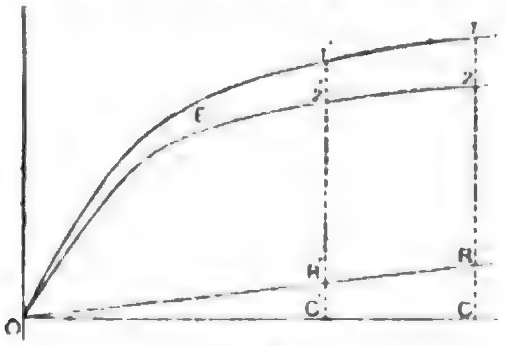


Fig. 6.

The Line.

I pass now to the consideration of the line, a subject of great mportance, especially in long-distance transmission, since in hese cases the cost of the line forms a very large item in the otal cost of plant. You are all familiar with Sir William Thomson's law for greatest economy in conductors. Briefly, he reasoning on which this law has been developed is as ollows: The annual cost of power delivered is made up of two tems. First, the cost of the power only, and secondly, the nterest on the capital outlay. The cost of power includes that mount which is wasted in heating the conductor. If I thereore wish to work with the greatest economy, the sum of annual nterest on the capital outlay and cost of power wasted must be minimum; and this condition is attained when the two are qual. Profs. Ayrton and Perry were the first to question the ractical applicability of this law. In a paper read by them efore the Institution of Electrical Engineers in March, 1888, hey showed that under certain conditions better economy can e obtained by departing from, instead of following, Sir William Thomson's law. I do not propose to give you quotations from heir paper, which is highly mathematical, but I will endeavour o put the subject before you in a different way, requiring only ery little mathematical treatment.

First of all, let us see in a general way what Sir William Thomson's law really means. It supposes that the annual lectrical horse-power has a definite value at any place reached y the conductor. This is generally assumed for the distriuting system as carried out from central stations. Whether a ustomer lives 100 yards or 500 yards from a central station, he company charges him the same for the current. But the assumption is not, strictly speaking, correct. To see this, let us suppose that the cost to the company of putting an annual horse-power into their mains is £20, and they get £30 for every annual horse-power taken by the customer. Now, if I lose 1 h.p., shall I be right in writing off this loss at £20. Clearly not; for if I had not lost this particular horse-power, I might have sold it for £30. But there is another way of looking at this. You might say that the £10 difference between the cost and selling price of power represents profit and interest of plant and mains, and that, therefore, the lost power should be debited at net cost. To this I reply that my object is not to put power into the mains, but to take power out, or, rather, enable my customers to take power out, for which they will pay me; and so we might keep arguing the question, without ever coming to a definite understanding. Now, if we cannot settle such a simple problem by common-sense reasoning, there must be something wrong in our premises; and, in this case, it is not difficult to see where the hitch is. It is in the assumption that the power has a constant value. In reality, this is never the case. If it were the case—that is to say, if 1 h.p. had the same value at the motor end as it has at the generator end of the line—it would be perfectly useless to establish a transmission plant; it would be like carrying coals from Cardiff to Newcastle. It is only because the power has a great value at the motor end of the line, and a small value at the generator end, that it will pay us to lay out capital in plant, and incur the risk of working it.

Most Economical Current for Electric Power Transmission.

D	Distance in miles.
a	Section of conductor in square inches.
E	Terminal volts at generator.
e	Terminal volts at motor.
HP_g	Brake horse-power required to drive generator.
HP_m	Brake horse-power obtained from motor.
c	Current in amperes.
	Efficiency of generator, 90 per cent.; efficiency of motor, 90 per cent.
g	Cost in £ per electrical horse-power output of generator.
m	Cost in £ per brake horse-power output of motor, including regulating gear.
$G = \cdot 9\, g\, HP_g$	Cost in £ of generator.
$M = m\, HP_m$	Cost in £ of motor and regulating gear.
$t = 18 \cdot 2\, D\, a$	Weight in tons of copper in line.
K	Cost in £ per ton of copper, including labour in erection.
s	Cost in £ of supports of line per mile run.
p	Cost in £ of one annual brake horse-power absorbed by generator.
q	Percentage for interest and depreciation on the whole plant.

$$\text{Capital outlay} = g\,\frac{E\,c}{746} + m\,HP_m + D\,s + \frac{1 \cdot 6\, K\, D^2\, c^2}{E\,c - 830\, HP_m} = A.$$

$$\text{Annual cost per brake horse-power delivered} = q\,\frac{A}{HP_m} + p\,\frac{HP_g}{HP_m}$$

$$\text{Put } B = \frac{E\,p}{670} + q\,\frac{E\,g}{746}.$$

$\gamma = \frac{830}{E}\, HP_m$, the current which would be required if the line had no resistance,

and $\beta = \gamma^2 \frac{E\,B}{1 \cdot 6\, q\, K\, D^2 + E\,B}$; then the most economical current at the given voltage, E, is

$$c = \gamma\left(1 + \sqrt{1 - \frac{\beta}{\gamma^2}}\right)$$

$$c = \gamma\left(1 + \sqrt{\frac{1 \cdot 6\, q\, K\, D^2}{1 \cdot 6\, q\, K\, D^2 + B\,E}}\right)$$

For very long distances the term under the square root approaches unity and the most economical current the value 2γ; from which it follows that under no circumstances will it be economical to lose more than half the total power in the line.

The correct way of treating this problem is, therefore, to take into account the cost of the power, both at the generating and at the receiving station. We must, further, take into account not only the interest and depreciation of the line, but also the interest and depreciation of the machinery at either end; and in estimating these items we must know at what voltage the plant is to work, and what total power is required; for the prime cost per horse-power depends very materially on the total power and voltage. To make this clear, if I want to reduce the capital outlay on the line, I must work at high voltage, and with a large energy loss. This means that I must put down a larger generator than would otherwise be required, and, moreover, one that gives an high-pressure current. It is thus quite possible that what I save in the line I shall have to expend at the generating station, to say nothing of the increased charge for waste power, and the greater liability to have a breakdown owing to high voltage.

You see this problem is a very complicated one, and

Thomson's law, which says nothing about voltage or cost of machines, will not fit it. It is, however, possible to amend this law, so as to obtain at least an approximate solution. The premises on which the formula has been deduced are as follows :

Conditions given.—Annual value of brake horse-power at generating station ; voltage at generator terminals ; brake horse-power required at motor end ; distance of transmission ; cost per horse-power of machines and regulating appliances at the given output and voltage ; cost of conductor, per ton of copper erected, interest, and depreciation of whole plant.

Data required.—Working current, brake horse-power at generating station, mechanical efficiency, voltage at motor, total capital outlay per brake horse-power delivered, and cost of annual brake horse-power.

The efficiency of each machine is assumed to be 90 per cent. The formula gives only the current, but the other data can be found by very simple calculations which need no explanation. The cost of supports for the line per mile, whether overhead or underground, can be taken as constant—that is, not depending on the exact current within the limits—which can easily be foreseen in each case ; and it therefore does not enter into the formula for the current. Interest and depreciation I have taken the same for all parts of the plant, so as to avoid too great a complication of the formula. If you now work out by the aid of the current formula the same transmission problem for different voltages, you will find that there is one particular voltage for which the annual cost of the brake horse-power delivered at the motor end of the line is a minimum ; and provided this voltage is within reasonable limits, it ought to be adopted. When making such calculations, you will find that the greater the cost of power at the generating station, the higher is the most economical voltage, this voltage also, of course, increasing with the distance.

Each case must be worked out with due regard to local conditions, and nothing in the shape of cut and dried rules or figures can make this work superfluous. On the other hand, it is very desirable to collect information as to the cost of works which have actually been carried out, and by the liberality of Mr. Brown, the engineer to the Oerlikon Works, Switzerland, I am able to place before you some figures of this kind which are contained in the following table. The figures give the whole capital outlay for the electrical parts of some of the power transmissions erected by this firm.

COST OF TRANSMISSION OF POWER PLANT.

Distance in miles.	H.P. delivered.	Speed of machine.	Cost in £			Total cost.* £	Cost per H.P. £
			Gen.	Mot.	Line.		
1·870	85	450	640	560	440	1,880	22·2
·280	195	500	760	680	132	1,800	9·7
·280	51	600	320	280	60	720	14·1
·375	90	550	520	480	80	1,240	13·8
·560	71	600	440	400	60	1,040	14·6
·280	40	700	260	240	20	640	16
·375	75	600	480	440	68	1,120	15
·500	87	500	520	480	100	1,260	14·5
1·560	150	600	760	720	330	2,050	13·7
·220	93	450	440	420	232	1,270	13·7
6·250	11	900	132	110	480	960	87
2·200	51	600	360	320	300	1,140	22·4
·187	60	900	240	220	18	600	10
5·000	41	750	240	200	344	1,020	24·8
3·750	220	600	1,040	960	640	2,960	13·5
·002	15	600	112	104	8	252	16·8
·250	19	700	160	160	20	390	20·5

* This includes regulating apparatus, instruments, posts, insulators, lightning arresters, erection, and supervision.

LEGAL INTELLIGENCE.

ORIENTAL TELEPHONE COMPANY.

Enlarging the Scope of the Company's Operations.

In the Courts last week Mr. Cozens-Hardy, Q.C., appeared before Mr. Justice Romer for this Company, which had presented a petition for the confirmation of a special resolution enlarging the scope of the Company's operations. He said the Company was formed for the purpose of carrying on telephonic communication in the East, and was engaged in very large operations, partly in its own name and also by supporting and holding shares in other companies carrying on operations in Bombay, Bengal, China, and Japan, etc. Some of these companies had power by their articles to carry on other electrical business, and the Company itself having an expensive and skilled staff, was frequently applied to to supply electricity for lighting and other purposes, but was advised that they could not do so under the existing memorandum.

Mr. Justice Romer pointed out that in this case the name would require to be altered. When that was done he should be prepared to sanction the resolution.

COMPANIES' MEETINGS.

CROMPTON AND CO.

The third annual general meeting of this Company was held at the Cannon-street Hotel on Wednesday afternoon, Mr. R. E. B. Crompton, one of the managing directors, in the chair.

The **Secretary** (Mr. Reeves) having read the notice convening the meeting,

The **Chairman** said : Gentlemen, you have had the report (this was given in our last issue), and I assume that it may be taken as read. I have now to move that the report of the Directors and the audited statement of accounts for the year ending 31st March, 1891, be, and the same are, hereby approved and adopted. With respect to the statement of accounts, I think the shareholders will agree with me that the balance of net profits, amounting to slightly over £13,000, shows a satisfactory rate of increase on the balance of the previous year, and justifies the remarks I made to you at the last year's meeting as to the probable steady increase of this Company's business. During the current year we have executed several important contracts, and our turnover has largely increased. But, as I explained to you last year, these large contracts were taken at fixed rates of profit. At the same time these contracts constitute a very safe and satisfactory feature of the Company's business—a feature we hope to see extended during the current year. Among the important orders we have in hand, is one for lighting the city of Pretoria, which is the capital of the Transvaal. In connection with this contract, Mr. J. F. Albright has visited South Africa recently, and will explain to you that there is every probability of our doing a large business there. Contracts are in progress for important central stations on the Continent, any one of which may be decided shortly, and any one of which will result in a large increase in our turnover. Negotiations are also in hand for several large towns in England. We think we stand a good chance of securing a fair proportion of these orders, and these will secure a safe and fairly remunerative profit for our shareholders. A firm like ours, which has always to occupy a leading place among manufacturers, has to keep abreast of improvements, and, in fact, we have to introduce improvements. During the last year we have perfected a system of electric railways, and succeeded in carrying out for the Southend Local Board an exceedingly successful example of the modern electric railway, which has received the highest encomiums from everyone connected with it ; the consulting engineer (Dr. John Hopkinson) himself saying that he had never passed a final certificate with so much satisfaction. Another cognate branch of our business during the year has been electrical underground haulage for mines. We have recently carried out two very large sets of such haulage with complete success. In both cases we transmitted upwards of 100 h.p. The last case was one in South Wales. It was successfully started last Friday close to Merthyr Tydfil. I may say in connection with this that colliery managers who witnessed the experiments said we could book enough orders to keep our works going with this alone. These installations don't show in the accounts under consideration ; they come into the accounts of the present year. I ought to mention, in connection with the success of electric haulage, that a great deal is due to our South Wales agent, Mr. J. C. Howell. We have expended a considerable amount on capital account, partly in increasing our buildings and fitting up our works at Chelmsford, but partly in fitting up Lillie-road works in London. These are of very great use to us, and we should not be able to carry out our London work without them. Coming to the statement of accounts, I would refer to the question of debentures. At the last meeting I informed you we had decided to issue the second £25,000 out of £50,000, and we offered them to our shareholders ; but the response was not as satisfactory as we expected it would be. At the date of this present report only £31,050 debentures had been subscribed—or a little over £6,000 since last year's meeting. At the present moment we have over £15,000 of these debentures to be placed. We have not pushed the issue of them by advertising, but we now find it really necessary that the Company should have this additional capital, and the Directors would be glad if shareholders would send in their applications so as to close the list by subscribing for the balance. The debentures are amply secured, and as the total interest on the issue is only £2,500, and the profit is now £13,030, there is little doubt but that the debenture holders will receive their money in the future as in the past. To exemplify the use of capital, I may say that we were able last year to secure for the Company, by prompt payment of accounts, an extra profit in the shape of cash discount ; and that this sum was in excess of the total amount required for the whole of the debentures then issued. With regard to the distribution of the net profit, you will see the Directors propose, after setting aside £500 for bad debts, to pay a dividend of 3s. 6d. per share, making 7 per cent. per annum on the preference shares, and 5s. 6d. per share, making, with the interim dividend, a total of 8 per cent. per annum on the ordinary shares. I may say that the good feeling which I stated in my speech last year existed between ourselves and our staff of workpeople still continues. I have to thank the staff for the satisfactory way in which they have worked during the past year, and the works' managers for the immense pains they have taken in promoting the working of the men's sick clubs. I shall have great pleasure in answering any questions from shareholders present. I conclude by moving the resolution mentioned above—viz., that the report and accounts be received and adopted. Mr. Albright, who has had a long business tour round the world, returned home two days ago, and will give you a statement as to the results of his journey.

The resolution was seconded by **Mr. Carleton F. Tufnell**, and carried unanimously.

The **Chairman** moved the payment of the dividends on the preference and ordinary shares, which was carried. He then informed the shareholders that since the last meeting they had lost a very valuable director in the person of Sir Charles Grant, who, owing to his no longer residing in London, had regretfully given up his directorship. The Board had appointed Mr. H. H. J. W. Drummond, who had served some time and proved of valuable assistance to them. Quite recently they had secured the services of another extremely valuable director, Viscount Emlyn, who was on the Board of the Great Western Railway. The acquisition of this gentleman gave them very great strength, and he was experienced in the management of large bodies of men. His railway connection could not fail to be of value in forwarding the cause of the Company, while he had very greatly increased their influence in the West of England. He moved the approval and confirmation of the appointment of these Directors.

This was seconded by **Mr. G. S. Albright**, and carried unanimously.

Mr. Gibson, the retiring director, having been re-elected,

Mr. J. F. Albright said that he had been alluded to as having just returned from an extended trip round the world, and though he had not had time to think out any elaborate statement of his travels, he would, in a few words, give them a general impression of what he had seen. He first visited Canada, and met there the agents they had recently appointed. He had every reason to be satisfied with the agents, and he believed that the orders they had sent home since his visit had been of considerable importance. He also visited the United States, but, as they were probably aware, owing to the extremely high tariffs, it was almost impossible to do any business there, although they were doing a certain amount. After that he went to Australia and saw their Company which had been established there. His impression of the country, and the way in which it was being worked, was that, although there were many things to be improved upon, still they were better represented than any other English or European firm; probably only one firm was in a better position than they were, and that was an American one. Of course, in Australia the prospect of business was considerable, but, at the same time, it could only be done by people who knew the country well and were well known in the country; and that was one reason why they might consider they were well represented there — the people were old-established residents. He was only a short time in India, but he arranged for their being represented by an old-established house in Calcutta—the oldest house there, and also one that had done more electrical work than any other. From India he went to the Mauritius. Here there was no work left to be done, and no money to pay for any. Leaving the Mauritius he next went to Natal, and up to Pretoria, where he made the final arrangements for lighting the town. The fact of their having obtained that contract was likely to be the means of establishing for them a very considerable and valuable business throughout South Africa. He had also made arrangements for their being represented in the Transvaal, and was asked to report to the Town Council of Durham and met representatives of the Town Council of Capetown. As a result there was a fair prospect of business being done. Altogether he might say that having been round the world he was better able to meet the questions they might have to deal with, and therefore he had the greatest satisfaction in having made the trip.

The re-election of the Auditors having been unanimously carried, a hearty vote of thanks to the Chairman brought the proceedings to a close.

MANCHESTER EDISON-SWAN COMPANY.

Report.

The Directors beg to submit the accompanying balance-sheet for the year ending 30th May, 1891. The net profit, including last year's balance, amounts to £2,292. 10s., which it is proposed to appropriate as follows:

To payment of dividend at 5 per cent. per annum ...	£1,000	0	0
To payment on account of 5 per cent. cumulative preferential dividend on the "A" shares at the rate of 1¼ per cent. on £40,000 (the original paid-up capital of the Company), for the year ending 31st May, 1883	500	0	0
Balance to be carried forward	792	10	0
	£2,292	10	0

If the above be approved, the dividend warrants will be issued on 1st August, 1891. Since the last general meeting the Directors have had to deplore the loss, by death, of their esteemed colleague, Mr. Edward Cross. The Directors have filled this vacancy on the Board by the election of Mr. Frederick B. Ross as a director of the Company. Mr. W. P. James Fawcus, the Company's manager, has been elected to fill the vacancy on the Board caused by the resignation, through ill-health, of Mr. J. R. Williamson, and the shareholders are asked to confirm his appointment as director. Mr. Frederick B. Ross retires in accordance with the Company's articles of association; he is, however, eligible, and offers himself for re-election.

The ninth ordinary general meeting of this Company was held on Wednesday in Manchester, Mr. V. K. Armitage, chairman, presiding.

The **Chairman**, in moving the adoption of the report, explained that the dividend of 1¼ per cent. on the £40,000 was on the original capital, which was entitled to 5 per cent. cumulative dividend before any money out of profits was paid on the B shares to the present Company, and now, for the first time, they were able to come back to 1883 and pay something on account of the £40,000. The amount it was proposed to pay was £500, and it came to 1¼ per cent. The report and accounts showed that they had made a profit of £1,645, and adding to that £647. 6s., balance from last year, they had at their disposal £2,292. 10s. Since the extraordinary meeting of the Company was held some months ago, the Directors had tendered for one or two large installations, but they did not see that they would make very much out of them if they got them, and so they did not persevere with them. They had come to the conclusion that their money might very well be spent in another quarter altogether. Some 18 months or two years ago, when Mr. Williamson, who was then the managing director of the Company, went out to Sydney for the benefit of his health, five or six of them, who had confidence in his trustworthiness and ability, joined together and formed a little company with a nominal capital of £5,000, of which £2,500 was called up. Well, Mr. Williamson had not been out in Australia 12 months before orders were pouring in upon them, and they foresaw a time when the capital of the little company would be as a mere drop in the bucket. It was then suggested that instead of allowing the money of the Manchester Edison-Swan Company to lie idle at the bank, it would be well to invest it in shares in the Williamson Company, and after considerable deliberation with those directors of the Edison-Swan Company who were not in the smallest degree interested in the Williamson Company, they arrived at the unanimous conclusion that it was the best thing they could do; £2,500 of the Company's money had accordingly been invested on advantageous terms in the Williamson Company. Mr. Williamson had a great deal of business in hand, and when that was got out he had good ground for hoping that he would be able to get more. With regard to the prospects of the Company, he could add little to what he had said at previous meetings. They had tendered, together with a number of other firms, for the lighting of the Manchester Town Hall, and they were hopeful that their tender might be successful. They sincerely believed that when they had got the Town Hall lighted with electricity it would be such an improvement on the present arrangement that the Corporation and the citizens would be encouraged to use the electric light more freely. In conclusion, the Chairman assured the shareholders that the price at which the shares of the Company were knocked about on the Stock Exchange did not by any means represent their intrinsic value. Unless to people who were buying or selling the shares for gambling purposes, it did not matter one straw at what price they stood on the Stock Exchange. The great thing was, what did the shareholders get at the end of the financial year on the amount of money they had invested? He thought that was the way in which to judge the *bona fide* value of the shares. He moved the adoption of the report and accounts.

This was seconded by **Mr. I. C. Waterhouse**.

In reply to a question by Mr. C. Agnew, the **Chairman** stated that the Directors were acting quite in accordance with the articles of association in entering upon the Australian business. In the past, so long as they could make a profit, they had not hesitated to do business in any part of the world.

Mr. Becker, while not seeking to cast a doubt on the probable profitableness of the Australian business, said he thought the Directors had been somewhat unceremonious in launching out into such work without consulting the shareholders.

The **Chairman** defended the action of the Directors, and the resolution for the adoption of the report was carried unanimously.

The dividends recommended in the report were declared payable, and the thanks of the shareholders were accorded to the Directors, to whom a sum of £150 was voted for their services.

COMPANIES' REPORTS.

TELEPHONE COMPANY OF IRELAND.

The report of the Directors for the year ending December 31, 1890, states that inasmuch as the articles of association require that the accounts shall be made up to a date not more than four months before the annual meeting, a supplementary statement of accounts is also presented herewith for the half-year ending June 30, 1891. The negotiations for the raising of additional capital have now been satisfactorily concluded. The Company is now entitled to some reduction of the instrument royalties, and, in accordance with the terms of the agreement between the United Telephone Company and this Company, the amount of such reduction will be settled by arbitration. The accounts now submitted are therefore subject to adjustment, according to the decision of the arbitrator. The amount standing to the credit of the net revenue account as upon December 31, 1890, including the balance brought from last account, amounts to £4,950, against £4,459 for the year 1889. Out of this sum there has been paid an interim dividend upon the preference shares for the half-year ended

June 30, 1890 (£1,138 paid in July last), leaving an available balance of £3,813, as shown in the balance-sheet, which the Directors propose to allocate as follows: For the payment of the debenture interest, £49; for the payment of balance dividend upon the preference shares for the second half of the year (£1,153); and to place to the credit of the reserve fund £464. 13s. 6d. (being 10 per cent. of the net profits of the year), carrying forward the balance of £2,146 to credit of the current year.

UNITED RIVER PLATE TELEPHONE COMPANY.

The report of the Directors for the year ended March last states that the result, after meeting expenditure and debenture interest, was a profit of £38,480. 14s. 4d., from which £36,049. 0s. 8d. has to be deducted for loss on exchange, leaving a net profit of £2,431. 13s. 8d., increased to £4,805. 10s. 2d. by the addition of the sum brought down. The Directors recommend that £768. 7s. 8d. be applied in writing off one half of the taxes suspense account, £2,000 be written off for bad and doubtful debts in the River Plate, and that the balance of £2,037. 2s. 6d. be carried forward.

ANGLO-AMERICAN TELEGRAPH COMPANY.

The report of the Directors for the first half of the current year has been issued. Second quarterly dividends of 12s. per cent. on the ordinary stock and of £1. 4s. per cent. on the preferred stock are recommended, leaving £527 to be carried forward. It is stated that the appeal of the Anglo Company was argued before the French Council of State on May 1 last, and the decision of the Council of Prefecture was reversed in the Company's favour. The case will now be heard by the Court of Appeal on the question of damages, and it is expected that judgment will be pronounced soon after the termination of the long vacation.

NEW COMPANIES REGISTERED.

Home Telephonic Company, Limited.—Registered by H. P. Spottiswoode, 32, Craven-street, Charing Cross, with a capital of £500 in £5 shares. Object: to contract for the carrying on of any telephonic, telegraphic, or any other electrical business.

Tayler-Smith Electric Company, Limited.—Registered by Cave and Co., 4, Fenchurch-street, E.C., with a capital of £6,000 in £10 shares. Object: to acquire the undertaking of Thomas Tayler-Smith, 4, Circus-place, London, and to carry on thereat the business of an electric engineer and electrician in all its branches. The first managers of the Company are T. T. Smith and Major Keppel Stephenson. Neither qualification nor remuneration specified.

CITY NOTES.

Cuba Submarine Telegraph Company.—For the past half-year the Directors recommend a dividend at the rate of 8 per cent. per annum.

City and South London Railway.—The receipts for the week ending 25th July were £686, against £689 for the week ending 18th inst.

PROVISIONAL PATENTS, 1891.

JULY 20.

12285. **A magneto advertising or displaying device.** Albert Augustus Goldston, Post Office-buildings, Middlesbrough.

12286. **Economic electromotor and motive power.** Claud Salusbury Foljambe Mellor, 8, Lyric-chambers, Whitcomb-street, Haymarket, London.

12296. **Improvements in apparatus for the manufacture, by electrolysis, of tubes and other articles of circular section.** Alexander Stanley Elmore, 28, Southampton-buildings, London.

12313. **Improvements in electric batteries.** Edmund Christian Conrad Jungnickel, 323, High Holborn, London.

JULY 21.

12322. **Improvements in or relating to electrical welding.** Alfred Julius Boult, 323, High Holborn, London. (John H. Bassler, United States.) (Complete specification.)

12384. **Improved compound for insulating electric wires in general.** Murdoch Mackay, 166, Fleet-street, London.

JULY 22.

12415. **Improvements in and relating to quick hitching harness and its operation by electric current.** Francis Elliott Stuart, Volthurst, Twickenham.

12416. **Improvements in telephonic transmitters.** Alexander Marr, 70, Market-street, Manchester.

12455. **Improvements in electric locomotives.** Jasper Wetter, 433, Strand, London. (Henri Bonneau, France.) (Complete specification.)

JULY 23.

12484. **Improvements in telephonic switching apparatus.** Alfred Rosling Bennett, 22, St. Albans-road, Harlesden, London.

12491. **Improvements in the construction of rheostats or similar electrical instruments.** Charles Lawrence Baker and Woodhouse and Rawson United, Limited, 88, Queen Victoria-street, London.

12503. **An improved electric ear-ring for curative and remedial purposes.** Edward Owen, 37, Chancery-lane, London.

12525. **Electrical steering gear.** George Sylvester Grimston and Alfred Herbert Dykes, 28, Southampton-buildings, London.

12529. **Improvements in means for distributing electric currents.** Henry Edmunds, 47, Lincoln's-inn-fields, London.

12531. **A new or improved apparatus for producing pictures upon a screen in stereoscopic relief by means of electricity.** Désiré Bouchard, 35, Southampton-buildings, London.

12535. **Improvements in switches for electric installations.** Alfred Vincent Newton, 6, Breams-buildings, London. (Alfred Swan, United States.)

12540. **Dynamo-electric machines.** Hermann Cuénod, Ernest Sautter, and Georges Hochreutiner, 24, Southampton-buildings, London. (Date applied for under Patents Act, 1883, sec. 103, December 31, 1890, being date of application in Switzerland.) (Complete specification.)

12541. **A system for the automatic regulation of the position of the brushes of dynamo-electric machines, magneto-electric machines, and electric motors.** Hermann Cuénod, Ernest Sautter, and Georges Hochreutiner, 24, Southampton-buildings, London. (Date applied for under Patents Acts, 1883, sec. 103, December 31, 1890, being date of application in Switzerland.) (Complete specification.)

JULY 24.

12592. **Improvements relating to the manufacture or preparation of carbons for electric lamps or lighting apparatus.** Henry Harris Lake, 45, Southampton-buildings, London. (Lacombe and Co., France.)

12602. **Improvements in apparatus for measuring electric currents.** Hermann Aron, 6, Lord-street, Liverpool.

12605. **Improved means for securing terminals or binding-screws to plates or electrodes for electric batteries.** Henry Harris Lake, 45, Southampton-buildings, London. (Lacombe and Co., France.)

12611. **Improvements in or connected with the electrolytic deposition of copper.** Joseph Wilson Swan, 47, Lincoln's-inn-fields, London.

JULY 25.

12622. **An improvement in electric clocks.** Nugent Wells, 22, High-street, Newport, Mon.

12628. **Improvements in couplings and terminal connections for electric cables.** Joseph John Hargreaves and Ratcliffe William Nuttall, 20, Charles-street, Bradford.

12634. **Improvements in apparatus for electrical sound and sight signalling on railways and other lines of rail.** Archibald Drummond Macdonald and James Dodd, 26, Spellow-lane, Liverpool.

SPECIFICATIONS PUBLISHED.

1889.

6745. **Electrolysis of substances in fusion.** Kiliani. (Second edition.) 8d.

1890.

10624. **Dynamo-electric machines.** Scott. 8d.

12475. **Electrical smelting.** Taussig. 6d.

12713. **Electric mains.** De Ferranti. 8d.

13619. **Electric conductors.** Lineff. 8d.

13735. **Electro-metallurgical operations.** Hoepfner. 8d.

1891.

5963. **Electric "hooter."** Saunders and Brown. 8d.

8555. **Insulated electric conductors.** Thompson (Williams). 8d.

9435. **Electrical transformer.** Lauckert. 6d.

9436. **Electrical transformer.** Williamson. 6d.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Brush Co.	—	2¼
— Pref.	—	1⅛
India Rubber, Gutta Percha & Telegraph Co.	10	19½
House-to-House	5	5
Metropolitan Electric Supply	—	10
London Electric Supply	5	2
Swan United	3½	4½
St. James'	—	6¾
National Telephone	6	3
Electric Construction	10	7¼
Westminster Electric	—	5

NOTES.

Ballinskelligs.—The Direct United States Cable Company are about to commence at once the erection of a telegraph station at Ballinskelligs, a short distance from Valentia Island.

Prince of Monaco's Yacht.—This yacht, which is built and fitted up for scientific purposes, is lighted throughout by electricity. The installation has been carried out by Messrs. Woodhouse and Rawson.

Christiania.—The Christiania Corporation are inviting tenders for the erection of electrical works for about 12,000 lamps. Tenders are to be sent in, addressed to the Christiania Magistracy, by September 12.

New Cables.—The Western and Brazilian Telegraph Company, Limited, state that an expedition is now in Brazil laying new cables from Santos to Rio de Janeiro, Rio de Janeiro to Bahia, Bahia to Pernambuco.

Electric Railways in Italy.—A scheme, it is stated, is under consideration for the construction of an electric railway from Aosta to Pré-Sainte-Didier. The project will, if carried out, bring into existence the longest electric railway in Europe.

Electric Cars for Edinburgh.—The Lord Provost's Committee of the Town Council have under their consideration at the present time a proposal to experiment with electric cars in Leith-walk with the overhead wire method common in America.

Dalton Local Board.—A letter from Messrs. Nicholson and Jennings having been read at the Board's monthly meeting as regards lighting the streets with electricity, it was decided to refer the matter to the Highways and Lighting Committee.

Waterford.—A special meeting is to be held by the Town Council on September 1 to consider the advisability of applying to the Board of Trade for a license to supply electricity for public and private purposes. It is estimated that if a license is obtained the Council will approach the electric lighting company with a view to purchase.

Montrose.—The new hospital lately added to the asylum, the main building, and superintendent's house are electrically lighted. Manchester dynamos, driven by high-speed engines, are used, and, as a stand-by, a battery of accumulators sufficient to supply current to 50 lamps for 10 hours is installed. Altogether there are some 430 16 c.p. incandescent lamps.

Southampton.—Tenders are being invited by the Southampton Harbour Board for lighting the Royal Pier, Southampton, by electric light; also for providing and fixing two electrical cranes on the Town Quay, Southampton. Plans can be seen at the office of the engineer, Mr. J. G. W. Aldridge, 9, Victoria-street, Westminster. Tenders are to be sent in on or before the 24th inst.

Taunton.—The chairman of the gas company has been congratulating the shareholders upon the increased consumption of gas—and this in the face of competition with the electric light. This bears somewhat in favour of the views of many engineers that the introduction of the electric light should be favoured by the gas companies, in that it leads to the burning of more gas.

Electric Courting.—Paris, says the *Scientific American*, is laughing over a joke about an American inventor who is said to have patented an electric corset, calculated to bring about the reign of morality at once. If one of these articles is pressed by a lover's arm it emits a shriek like a railway whistle. The inventor claims to have already married off three of his daughters to their too backward lovers by the publicity thus thrust upon them!

Lampposts.—Electric Light: "Does your mother know you're out, Mr. Lamppost?" Lamppost: "Oh, yes; and you're to blame for it, too, you stuck-up thing, that you are." Electric Light: "Well, that's pretty strong, now; but then, you always were a little gassy, and a little, just a little, light in the head, you know." Lamppost: "You needn't talk, for you're a good deal lighter in the head than I ever was." Electric Light: "Oh, thank you."

Egremont.—At the monthly meeting of the Local Board, held last Friday, a report by the surveyor with regard to the utilisation of water power for electric lighting was considered, as was also other communications on the same subject. It was ultimately decided to adopt the motion of Mr. Simon, to the effect that a committee, consisting of Messrs. Smith, Bouch, Armstrong, Stout, and Davidson, be appointed to consider the letters, with power to call in professional assistance, if necessary.

Telegraph Engineers.—In reply to a question put by Mr. Webb in the House of Commons, the Postmaster-General stated that the engineering branch of the General Post Office performs work of a special character, and there does not appear to be any reason for making its classification uniform with that of another branch. The proposals affecting the pay of certain classes of engineering officers have been submitted to the Treasury, and are now receiving their Lordships' careful consideration.

Invention of the Electric Telegraph.—*Electricité* points out that Ampère and Babinet in 1822 mentioned that the deflection of a magnetic needle could be used to transmit signals to a distance. The application of it by Gauss and Weber, in 1833, published in 1834, at Gottingen, was considered by Gauss (Weber claiming no part of the discovery) as of only secondary importance. Our contemporary adds that it knows of no publication of actual results anterior to 1833, and if any exist would like to hear of them.

The Electric Light in Dentistry.—We now have the electric light to aid us in our dental operations, and I find, says Dr. Pruyn, by its use I can discover imperfections in cavities I have prepared that had previously escaped my attention. This is because the electric light gives a paler white light, and it is more intense than daylight. It is particularly so in that form of decay known as the white decay. You may prepare the cavity with the ordinary care, having it seemingly perfectly dry, and a magnifying glass will show you no imperfections, but with the aid of the electric light you find them.

Manchester Central Station.—The Cheshire Lines Committee have recently decided to erect an installation for the complete lighting of their central station, Manchester, and have placed the order for the whole of the plant with Messrs. Mather and Platt, of the Salford Iron Works. The plant will consist of incandescent lamps for the refreshment-rooms, ticket offices, and waiting-rooms, and of arc lights for the platforms. The plant is to be in duplicate throughout, and will consist of compound engines, Edison-Hopkinson dynamos for the incandescent lighting, and Manchester dynamos for the arc lighting.

Mercury Switch.—We notice that a "new type" of switch is described as in use at the works of M. Jacques Ullmann, in France, and others have introduced a similar arrangement for the avoidance of sparks at the point of contact. This is the use of a tube of caoutchouc or glass with two points of contact and a little mercury. On turning it one way the mercury falls on the contacts and completes the circuit. It may be well to mention that this form of switch was one of several publicly shown many years ago by Mr. J. W. Swan for use with his lamps, and it is possible was even then not an absolutely novel type of switch.

Cork.—A special meeting of the City Council has been fixed for Friday, September 4th, when the following will form part of the business to be transacted—viz., to take into consideration notice given by the Cork Gas Consumers' Company intimating their intention to apply to the Board of Trade for a provisional order under the provisions of the Electric Lighting Acts of 1882 and 1888 to enable them to supply electrical energy within the municipal limits of the city of Cork, and in connection therewith to consider whether or not the Council will consent to such application, and if so, on what terms and conditions such consent will be given.

Grassot's Electrolytic Meter.—M. E. Grassot has recently invented an electric meter dependent on electrolytic action, which is novel and has points of advantage. In principle the meter consists of a silver wire of a certain length placed in a glass tube. At its lower extremity the bare wire dips about one-tenth of an inch into a solution of nitrate of silver; it is dissolved and descends gradually with a speed proportionate to the strength of current. The wire is coiled around a drum, whose motion is registered upon dials. The cathode is formed by a ribbon of zinc in the vessel. The diameter of the silver wire is 5 mm. The apparatus has given very satisfactory results.

Battery Terminals.—In battery circuits it is advisable, of course, to eliminate all unnecessary resistance, and that caused by corrosion of terminal contacts is not the least cause of trouble. Messrs. Hayes and Hibbard, of the United States Long-Distance Telephone Company, have recently perfected a method of making contacts to obviate this difficulty, and keep the resistance at the lowest point. The connections are always made by a soldered joint, the solder being previously placed on the wires to be connected, so that it is only necessary to twist them together and apply moderate heat, such as that of a candle or spirit lamp. Perfect connections are thus made with the greatest facility, and can be unmade with equal ease.

City and South London Electric Railway.—In view of the extension of the line from Stockwell to Clapham, for which the company already have parliamentary powers, they are making arrangements for a considerable extension of the generating plant at the Stockwell Station. They have placed the order with Messrs. Mather and Platt, of Manchester, for a fourth generating dynamo similar to the three at present working the line. The dynamo is to be of Messrs. Mather and Platt's patent Edison-Hopkinson type for an output of about 400 h.p. The company have also ordered a fourth engine from Messrs. John Fowler and Co., similar to the three existing engines, and have made arrangements for an increase of their rolling-stock.

Shoreditch Vestry.—At the last meeting of this Vestry the Parliamentary Committee, after carefully considering the question of notices served upon the Vestry, of intention of three private companies to apply in the next session of Parliament for provisional orders giving them the power to supply electric light and power in this parish, recommended that "the Vestry apply in the next session of Parliament for a provisional order empowering them to supply electric light and power in this parish, and to transfer and let out the work hereafter, if thought desirable, and that the vestry clerk be instructed to take the necessary steps to obtain the order." It was decided to call a meeting on the first Tuesday in September for this purpose.

Interior Conduits.—During the last four months a great advancement has been made in the application of the method we recently described of interior conduits in buildings for electric wires, as well as telephone and other wires, by the Interior Conduit and Insulation Company, of New York. Already arrangements have been made for 22 public and office buildings to be fitted with interior conduits for the distribution of about 58,105 incandescent lights, without counting many private residences which vary from 160 lights to 700 lights each, and two or three installations of concealed wires for about 150 arc lights. Four of the office buildings out of the 22 have wires for telegraph, telephone, message service, etc., run in conduits, and one has speaking-tubes.

Electricity for Engineers.—The *American Engineer* makes a sensible suggestion that in working-men mechanical engineers' clubs there should be an electrical night once a week or so, and states that it has arranged for a number of first-rate electrical engineers to give lectures and experiments. It goes on, however, in an extraordinary way, after such a practical suggestion, to give a page and a half of mixed science, poetry, and Scripture, apparently to prove that the walls of Jericho were probably overturned by pulsations in their substance generating an electrical current. It might be a good thing if these proposed simple lectures by first-rate men were published instead of such stuff, which could only serve to muddle working-men's ideas, if they knew nothing of the subject, or to look ridiculous in the eyes of those who did.

Taking the Cake.—A contemporary says: "No scientific body in the United States has so many millionaires as the American Institute of Electrical Engineers. At the top of the list is Alexander Graham Bell, whose profits on the telephone are represented by eight figures. Next comes Edison with a seven-figure fortune. Brush, of electric light fame, Elihu Thomson, and Edward Weston are more than millionaires. Frank J. Sprague was a junior officer in the United States navy six years ago. He is now living in the mansion which was built for the Grants. His company sold out to the Edison Company for £250,000, and half of it went to the inventor. Messrs. Bell, Thomson, and Weston are all of British birth. Most of these men were telegraph operators, and most of them began their experimenting and study without a dollar."

Trade Amenities.—At the Leeds Assizes a case was tried which is undoubtedly similar to what occurs too frequently in trade matters—viz., the representative of one firm making invidious remarks as to the capabilities of another firm in order to get his own more favourably noticed. It is a great pity that men in business cannot give and take. One firm cannot obtain all the orders, and must be prepared to see competitors now and again successful. According to the jury's finding, Mr. Scott, at Bradford, has been mulcted to the tune of £75, it being held that he made some disparaging remarks about the firm of Messrs. Andrews and Preece. It seems that both tendered for the same work, and, according to the evidence, when Mr. Scott was told that the work was not to be given to him he made the remarks complained about.

Change of Address.—Owing to the increase in their London business, Messrs. Walter T. Glover and Co. have removed from 10, Hatton-garden, to larger and more commodious offices at Albany-buildings, 39, Victoria-street, Westminster, where they hope for the continued support of their electrical friends. Considerable alterations and extensions having been made in their works and machinery at

Manchester, they are now prepared to give prompt delivery from stock of wires and cables for electrical purposes in vulcanised, pure indiarubber, and guttapercha insulations, silk and cotton covering, and their patent braiding, also armoured and lead-covered cables in all sizes, concentric cables, and their patent anti-induction and other telephone cables. Mr. Henry Edmunds desires us to call the attention of his friends to his change of address as above.

Anti-Magnetic Alloys.—M. Roussaille, president of the Syndical Chamber of Watchmakers of Lyons, in his paper upon "Watchmaking" at the Paris Exhibition, cites the following anti-magnetic alloys employed in the manufacture of watches: (1) "Mangor," an alloy of manganese and gold; (2) "Wolfor," composed of wolfram and gold; (3) "Woltine," formed by the union of platinum and gold; (4) "Cadmine," an alloy of which cadmium forms a large part—it is very hard and very elastic. To the alloys mentioned by M. Roussaille are added: (5) "Aror," composed of cadmium, gold, and manganese, and (6) "Manium," formed of manganese, platinum, bismuth, and copper. The anti-magnetic alloy best known in England—Hadfield's manganese steel, composed of a small percentage of manganese, added to ordinary steel—does not appear to have been mentioned.

Electric Light Fishing.—A fishing sloop left San Diego, recently, on a novel expedition, to last from one to three months. An electric plant has been put on board, and the fishing is to be done by the aid of incandescent lights and a net. Experiments in the bay proved that everything alive under the water is attracted by the glare of the light, and that thousands of fish of every description can be taken in a short time and with very little trouble. Four men were on board, and the boat has steered for the banks near San Clemente Island. The practical result of the first voyage will be watched with much interest, and if it is as successful in deep water as the experiments in the bay have been, the projectors of the enterprise are confident they will have solved the problem of supplying all Southern California with cheap fish. W. G. Riffenberg, a citizen of San Diego, is the inventor of the apparatus.

Helston.—At the last meeting of the Helston Town Town Council, Mr. J. E. Veale, of St. Austell, who has been consulted on the question of electric lighting, gave as his opinion that the proposed lighting is practicable, and that the disposition of the town lighting will adopt itself well to the electric light. Three plans are suggested for carrying out the work; the first is to utilise the water power available at Lower Town to transmit the electricity from thence to a centre near the market-house and distribute it through the various streets and buildings by about five miles of underground cables. The second plan is to use gas engines with gas obtained on the Dowson system, and the third is to use oil engines. The estimated cost of the plans is, respectively, £2,070, £1,724, and £1,590. The annual cost is estimated at: water power, £198. 10s.; gas, £192. 4s.; and oil, £185. 10s. Letters on the same subject were received from the Manchester Edison-Swan, and from Messrs. J. E. H. Gordon and Co.

Sims-Edison.—The following is from the *Times*: "There is to be a new application, of high importance, of the Sims-Edison invention for propelling and controlling torpedoes, which was exhibited in May last at Havre and described at length in the *Times*. The principle of control has been utilised in connection with lifeboats by the distinguished scientist Mr. Edison and the eminent engineer, his colleague. At present a boat, with sides necessarily low enough for rowing, is propelled through the surf by 10 to 12 men, who, at the risk of their lives, produce about 1 h.p. The idea in the minds of Mr. Edison and Mr. Sims has been to exchange this feeble force for the all but unlimited power of electricity. The boat they have designed could be sent through the surf for miles up and down the coast, if necessary, and out to a vessel in distress with a force of 32 h.p. Only two men are required to steer it, and the elaborate devices necessitated by the torpedo are not needed."

Taunton.—We regret that we cannot enter fully into a description of the electrical exhibition, but at present merely say that Field-Marshal Sir J. Lintorn Simmons on Saturday performed the opening ceremony. The exhibition (which is held at the Taunton Electric Lighting Company's central electric lighting depot) is not large, but it is comprehensive, and is intended to illustrate the various uses to which electrical power can be applied. For instance, an oil engine drives a Newton dynamo, which conveys the electric current to a large number of electric incandescent lamps of various artistic shapes. The same power also drives small motors attached to sewing machines, and also warms a patent lubricator, by means of which eggs are hatched by electricity, and works a churn. An electric launch has been placed on the Tone, in which short trips are taken up and down the river. At a luncheon at which Sir J. L. Simmons was entertained, the gallant Field-Marshal referred to the Sims-Edison torpedo as being an important step in naval warfare.

Edinburgh.—The Corporation of Edinburgh have now obtained the Royal assent to their electric lighting provisional order. In the Act confirming it, which is known as the Electric Lighting Orders Confirmation (No. 6) Act, 1891, Edinburgh and Paisley were bracketed together. At Tuesday's meeting of the Town Council, Mr. Auldjo Jamieson asked what was to be done with it. Since Tuesday, the committee which was in charge of the order while it was in Parliament sat to consider what they were to do, and came to the conclusion that in procuring the order they had exhausted their duties; and that they could only report the matter to the Council, and wait for further instructions. "This does not look," says the writer in the *Journal of Gas Lighting*, "as if there was much eagerness to take up electric lighting; and I believe this to be the fact. Had it not been to keep out speculative companies, the provisional order would never have been heard of. Mr. Jamieson's question must, however, be answered; and it will be interesting to watch how the Corporation set about the carrying out of the very unwelcome task which has been thrust upon them by the order."

Frankfort Exhibition.—The work of transmitting 300 h.p. at a distance of 120 miles upon the line Lauffen, Frankfort, which was begun about the middle of July, is progressing very favourably. On the line Frankfort-Jagsefeld, which is being built by the Imperial Government, eight gangs of workmen are busily engaged, whilst three gangs are working on the Wurtemberg side. The vast material necessary for the building of the line, consisting of specially constructed telegraph poles, cross-bars, and insulators, having arrived on the spot in good time, and aided by the practical and energetic measures of the employés engaged upon the work, nearly all the telegraph poles along the whole line are in their places, in spite of unusual difficulties connected with the mountainous nature of the soil having had to be surmounted. Thanks to the exertions of the firm of Hesee Söhue Heddernheim, who delivered the necessary quantity of above 1,200 miles of copper wire at the respective places within the space of a few days, the putting up of the wires will begin next week. Not less than 750 kilogrammes of oil will be necessary to fill the insulators. There is now every reason to believe that the three wires of about 120 miles each will be fixed and in working order by the middle of August.

Canterbury.—At a meeting of the Canterbury Town Council on Tuesday, the town clerk read a letter from the Brush Electrical Engineering Company, saying that they were prepared to undertake the formation of a local company to take over the provisional order which the Corporation has obtained, and to refund the cost of the order, which they understood to be about £200, as soon as the necessary capital had been raised. Councillor Wells asked if the Brush Company were going to do it without any guarantee. The town clerk answered in the affirmative. Alderman Mount said he supposed if the Council accepted the offer it would be surrounded with safeguards in order to be on the safe side. The Mayor said at Dover they had advertised for tenders to take over the provisional order, but he did not know the result. Councillor Sanderson said he believed the tender of the Brush Company was accepted, and they were to form a company, and the Council would have the option of purchasing the undertaking at the end of 21 years. Alderman Mount said they had a better offer, with the option of buying at seven, 14, or 21 years. The Mayor proposed that their town clerk write to the town clerk of Dover asking him to send particulars of what had been done, and report at the next meeting, and this was agreed to by the members.

Lyons Electric Tramways.—The Lyons tramways seem to be run by a very enterprising company, and many experiments have recently been carried out to determine the most suitable method of mechanical traction. The fireless motors of the Frank and Lamm system, with superheated steam, were tried, then steam and petroleum engines, and, lastly, electric traction by means of cars carrying their own accumulators. The car is fitted with a motor by Alroth, of Basle, the current being supplied by 112 Faure-Sellon-Volckmar cells weighing 2½ tons, the gearing being a Gall steel chain. The cells are placed under the seats and in two cupboards at the end, and the motor is placed beneath the car floor, so that nothing is seen but the switch handle alongside that of the brake. The total weight of the loaded car may be analysed thus (giving the weights in hundredweights): Car 104, motor 13½, switch and resistance 2, 40 passengers 53, battery 47; total about 11 tons. The accumulators can be connected in four different ways, corresponding with 50, 100, 100, and 200 volts for 80, 40, 20, and 20 amperes respectively. The various couplings are brought about by a set of brush contacts under the car, moved by a handle with dial and figures. At normal speed, 7½ miles an hour (12 kilometres) on the level, the current is used at 10 amperes, rising to 30 and 45 on gradients. The capacity of the battery is 150 ampere-hours, so that a minimum run of eight hours can be achieved without recharge. The lighting of the car is taken off the cells at 50 volts. So far the experiment appears to have been very successful, and M. Paplew, the managing director, seems strongly inclined to increase the number of electric cars on the Lyons tram lines.

Boat Race by Telephone.—Through the enterprise of the telephone company of New Haven, Connecticut, the stay-at-home people were able to follow the Yale-Harvard boat race from beginning to end. Three wires were stretched from the telephone building in New Haven, one of which was flagged off to represent the course, the miles being designated alternately by red and blue flags. From the other two wires were suspended miniature boats, the crew of one being painted blue to represent Yale and the other red for Harvard. As the race progressed and the telephone reports were received, these were drawn along the wires and the relative positions of the crews were shown, giving a very good idea of the contest. Five stations, equipped with a long-distance transmitter, were placed one at the start, and one opposite each of the mile flags. At the instant the word "go" was given by the referee it was telephoned to New Haven by the station at the start, and the miniature boats began their journey across the street, a cannon being fired from the top of the telephone building to call attention to the fact. By this time the street was blocked, and the crowd continually increasing. Meanwhile the Harvard boat was slowly creeping away from its rival in accordance with the reports received, and by the time the first mile flag was reached it was fully three lengths ahead; at the same time a large bulletin was displayed in the window, giving the time of both crews to that point, their strokes per minute, and the shape they were rowing in. When either of the crews spurted the sham boats gave evidence of the fact, and the crowd hardly breathed until the suspense was over. After the race was over the crowd quietly dispersed, all giving praise to the telephone company for representing the race. It is the sort of idea that might be taken up in Fleet-street and our own universities.

Frankfort Congress.—The International Electrical Congress will be held from September 7 to 12 at Frankfort. It is proposed to organise into sections, as was the case with former congresses, and to discuss the prominent electric topics of the day. Among the papers already promised are the following, together with their authors: Carhart: (1) "The Substitution of Dynamo Machines for Voltaic Batteries in Telegraphy"; (2) "Current Regulators for Dynamo Machine"; Dolbear: "Electrical Terminology"; Von Dolivo Dobrowolsky: "Electrical Transmission of Power by Alternating Currents"; Epstein: "Applicability of Electromagnetic Measuring Instruments—that is, those containing Iron, for Alternating Currents"; Feussner: "Material and Construction for Measuring Instruments"; Frölich: (1) "Objective Demonstration of Harmonic Curves, and Electro-Acoustic Experiments," (2) "Generation and Application of Ozone"; Holborn: "On the Magnetic Action of Different Iron Alloys;" Hummel: "Direct Determination of the Work of Magnetisation and the Currents in an Iron Ring"; Kahle: "The Permissible Limits of Error in Measuring Instruments, in Relation to Heat, Remanent Magnetism, etc."; Kareis: (1) "Prevention of Cross-Talk in Telephone Wires Strung on the Same Pole," (2) "Prevention of Disturbances in Telephone Circuits by Induction from Wires Carrying Heavy Currents," (3) "Improvements in the Conductivity of Telegraph Lines"; Kohlrausch: "What is the Best Course of Study for the Education of the Electrical Engineer?"; Löwenherz: "Introduction of Uniform Screws in Electrical Work and Instrument Making"; May: "Regulations for Electrical Conductors from the Standpoint of the Fire Insurance Companies"; Meissner: "Application of Lippmann's Capillary Electrometer to Cable Telegraphy;" Muller: "Arrangement of Storage Batteries for Light and for Heavy Work"; Peukert: "On Electric Meters"; Rothen: "Important Questions in the Domain of Telephony." Papers have also been promised by Dubois, Ferraris, Grawinkel, Quincke, Alioth, Arnold, Görges, Slaby, and others.

Marx Process of Storing Electric Energy.—Mention was made some months ago of a liquid "electroline," which comprised the active material of an accumulator or battery instead of the plates. Great expectations were formed of it, and we believe Mr. Kapp reported upon it, but nothing further has been lately heard of it. The following particulars from the *Elektrotechnischer Anzeiger*

by Google

will, however, be interesting: The apparatus in use hitherto for the storing of electric energy (accumulators) are based upon certain chemical reactions which occur only at the electrodes, so that with apparatus of this type the same electrodes are obliged to be used for both charge and discharge. This is not without its inconveniences, especially when the discharge is to take place at some other place than the charge. In the Marx process the electrical energy is stored, not at the electrodes, but in a liquid subjected, by means of a special charging apparatus by means of the electric current, to a determined chemical change. This liquid, charged, so to speak, by the electric current, has been termed "electroline." The electrodes of charge may be any conducting substance, such as carbon; the discharge electrodes may be of metal. An example will serve to make the process clearer. A glass vessel is filled with 450 grammes of chloride of iron, 900 grammes of water, and about 500 grammes of hydrochloric acid. After the salt is dissolved, two or three plates (in the latter case two positive and one negative) are placed within the bath without touching and correspondingly connected to the positive and negative poles of a dynamo. The passage of the current causes a decomposition of the liquid, which turns greenish, then yellow, and finally passes to a yellowish brown. When the liquid will not absorb further energy, the negative plates are removed and then the positive. While the present accumulators only return their charge with the same electrodes, the electroline requires a change of plates, one of metal and one of higher resistance, such as carbon. A plate of very porous carbon on one well pierced with holes is placed between two metal ones—zinc, copper, or iron. If now the circuit is completed an energetic current is given off, while the liquid decomposes, passing by the same series of colours in inverse order.

Cuba-Brazil Cables.—On the 31st ult. the engineer-in-charge, Mr. Theophilus Smith, telegraphed that the Cayenne-Viseo section of these cables was successfully laid. This completes the system of about 2,500 nautical miles which Mr. Sharpey Seaton, the acting partner (for this special purpose) of the Société Générale des Téléphones, undertook to lay for the Société Française des Télégraphes Sous-Marins under contracts made in July and August of last year. The programme of the first expedition was drawn up on the 17th September, 1890. It was to commence on the 15th October and to last 78 days, but subsequently 14 days' extra work were added to the programme, thus extending it to 92 days. The "Westmeath" passed Dover on the 17th October outward, and on the 17th January homeward bound (92 days). The programme of the second expedition was drawn up on 6th March, 1891. It was to commence about 20th April and to last 117 days. The "Westmeath" sailed on 22nd April, and completed her work on the 31st July (100 days). The voyage would occupy 17 or 18 days if the "Westmeath" came direct, but it has recently been decided to give the ship extra work in laying the spare cable between St. Pierre and Fort-de-France and elsewhere. The "Ludgate" was taken up for a minimum period of four months; she will be redelivered to her owners before its expiration. During these four months she has been fitted with cable tanks and gear, has laid 2,250 tons of cable between Surinam and Brazil, and she is now being dismantled for restoration to her owners. The first expedition was directed by Mr. Seaton in person; the second by Mr. Theophilus Smith, who is assisted by Messrs. Stallibrass, Page, Schischkar, Hall, Roussel, Fisher, Bevan, Sullivan, Spain, and other engineers and electricians, as well as by Captain Stonehouse and Mr. Dunn, the chief of the engine-room. The first message over the new cable was addressed to President Carnot by the Governor of Guayana and the President of the Council-General. Of the cables above mentioned, about 1,000 miles were manufactured by Messrs. Henley and Co., in London, the remainder by the Société Générale des Téléphones, at their newly-established works at Calais. There are altogether some nine or ten different types of cable, but the shore ends are principally about nine-ton, and the main cable about four-ton cables.

Bacup Town Council.—At the monthly meeting of this Council Mr. Heyworth (town clerk) read the following letter relating to the electric lighting of Bacup: "Royal Insurance-buildings, Newcastle-on-Tyne, July 7th, 1891. Dear Sir,—In reply to your esteemed favour of the 26th ult. *re* electric lighting, we beg to say we have carefully considered the matter, and would suggest an installation of 100 arc lamps as suitable for your town lighting. The cost of such an installation—consisting of engines, boilers, dynamos, a suitable engine-house, 100 arc lamps each of 2,000 c.p. nominal, 100 iron lampposts, wooden poles to support overhead wires, insulated copper wire to fulfil Board of Trade requirements, and everything necessary to make a complete installation—would be about £9,000. The cost of working such an installation, if the authorities had it in their own hands and worked it themselves, would be as follows: Wages £4 per week, coal 4cwt. per hour, and carbons, etc., 2s. per hour, for the time all the lamps are burning. The light given by 100 arc lamps would be 100,000 c.p., whereas the light given by your present 632 gas lamps will, at best, not exceed 6,000 c.p. The annual rental, including purchase of plant, which we would charge for putting down, maintaining against all risks, and working the installation, under a guarantee to provide a constant and efficient light, would be about £25 per lamp per annum, plus the proportion of the cost agreed to be paid off annually, and 5 per cent. interest on the remainder. It would decidedly be to the advantage of the authorities for them to purchase the plant and work it themselves, and allow us to maintain it in good working order, at a very much reduced yearly charge. The current for incandescent lighting by private consumers could be generated at 2d. to 3d. per unit, which is equivalent to gas at from 1s. 2d. to 1s. 8d. per 1,000 cubic feet. The charge to private consumers in Newcastle is 6d. per unit, and in London 8d. per unit, so you will see that a fair profit could be derived from this source. Should your authorities think favourably of adopting the electric light we shall be glad to make a careful survey of the district, and give you a definite estimate, on payment of our representative's travelling expenses, and to give you any other information or advice in our power free of charge. Trusting the foregoing will be sufficient for your preliminary discussion,—We remain, yours obediently, Nicholson and Jennings. P.S.—Comparative cost of electric lighting and gas lighting:—British Museum: Electric light costs 6s. per hour, gas costs 15s. per hour; Albert Hall: Electric light costs £1. 10s. 6d. per night, gas costs £4. 7s. 6d. per night; South Kensington Museum: Electric light costs £1,224 per annum, gas costs £2,845 per annum. Thames Embankment: Electric light costs 5·66d. per 1,000 c.p. per hour, gas costs 1s. per 1,000 c.p. per hour. Dr. Cheadle, F.R.C.P., in a paper he recently read on 'The Progress of Hygiene,' says: 'The great injury inflicted by gas-polluted air is shown by the recent experience of the Great Western Railway Company. It is stated that since the electric light was introduced into their offices the percentage of absences from illness has fallen from 10 per cent. to 2 per cent. The introduction of the electric light will do much for the sanitation of houses, shops, and offices.'"

SIMS-EDISON TORPEDO.

From a note in another column it will be seen that the Sims-Edison electrical mechanism, as hitherto used for torpedoes, is to be applied to other boats, hence it may be as well to describe this mechanism a little more in detail. Fig. 1 represents diagrammatically the arrangement. It must be understood that the boat is regulated by an electric current generated at a fixed station, wires connecting the moving boat with the fixed station. Ordinarily at the station there is a steam engine of not less than 60 h.p., a dynamo, A, a key, B, an ammeter, a voltmeter, a battery, C, giving a current of 15 amperes at 20 volts, and a key, D. A cable connects the torpedo with the dynamo and battery. It consists of concentric conductors insulated from each other. The interior conductor has a section of 1·6 mm.^{2} to carry the battery current. The external conductor has a section of 15 mm.^{2} to carry the current of the dynamo. The whole is well insulated. The total diameter of the cable is 8·5 mm., and is tested under a current of 24,000 volts. One extremity is fixed at the station, the major portion of the cable at starting being rolled in a compartment of the torpedo, and is, of course, unrolled as required. This provides the means of guidance. It is unnecessary to enter into any detailed account of the torpedo itself, which is fairly well known. It contains several compartments, one of which is filled with the explosive material, which is supposed to contain about 250 kilogrammes of dynamite, or about 10 times the charge for the Whitehead torpedo—a sufficient charge to break up the most solidly constructed vessel at a distance of 50ft. The supplementary chamber, however, contains 400 kilogrammes of dynamite. The charge is fired by means of a detonator. A second compartment simply insulates the explosive charge from the rest of the torpedo. The third contains a cable wound in a hollow reel. It is so arranged as to permit the cable to be unrolled from the centre. The fourth compartment contains the propelling apparatus, and a supplementary arrangement for firing the charge. Here we find the series motor, Z, running at about 800 revolutions a minute, taking 28 amperes at 1,100 volts, giving 35 effective h.p. This motor actuates a screw. Besides rotating the screw, the motor also actuates a train of wheels shown at G H, Figs. 1 and 2, causing the projecting pieces shown at I to close the firing circuit. The firing apparatus is shown in M N P. The fifth chamber contains the governing apparatus shown in Fig. 4. It consists of two electromagnets, Q, placed symmetrically round the shaft of the screw. The armature, R, is connected through S to the rudder, T. Each of the electromagnets actuates a smaller armature, U, connected to a jointed lever, the extremity of which is connected through the terminal, *v*, to the terminal, W, whenever this extremity comes under the spring, *x*. The resistance, *y*, is interposed between the terminals, W, and *f*, and is equal to each of the magnets, Q. The governor is intended to vary the action of the rudder, and hence the direction of the torpedo. The rudder relay, or the relay governing the rudder, is shown in Fig. 3. It consists of an electromagnet, *a*, in the circuit of the battery, C, of a permanent magnet, B, and of two armatures, N S, which are prolonged in bronze pieces *d* d^1, Fig. 1. It is kept in ordinary position by springs *e* e^1, which are respectively connected with the terminals *f* f^1, and by these with the terminals, W W^1, of the apparatus governing the rudder. At the time of launching, the apparatus is as shown in the diagram, Fig. 1. The generating current comes by the terminal *f* to the motor, and can go to earth by three roads. First, by the resistance *y*, terminal W, lever U, wire *g*, armature d^1, terminal e^1, terminal f^1, motor, *z*, and to earth. The second road: terminal *e*, armature *d*, wire *g*, and then as by the first road. The third road is terminal *e*, electromagnet Q, wire *g*, and as before.

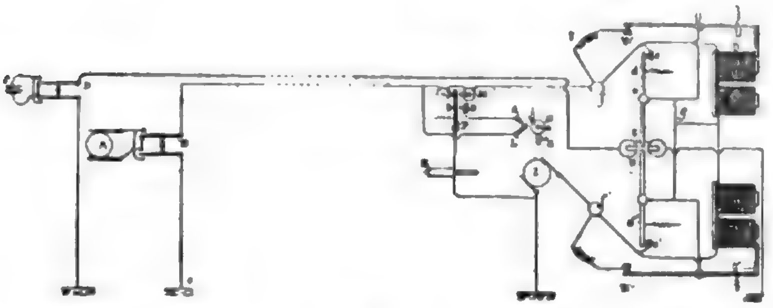


FIG. 1.

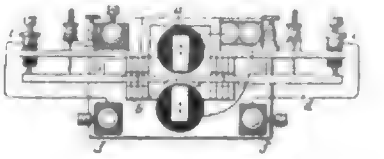


FIG. 3.

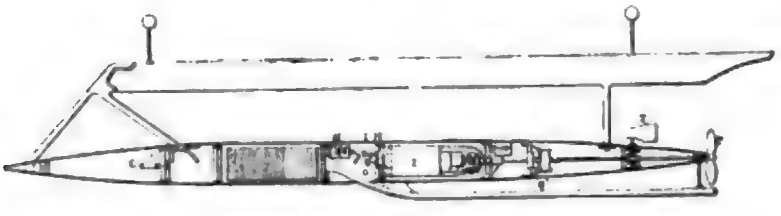


FIG. 2.

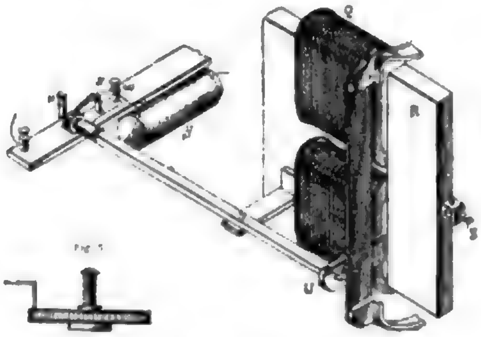


FIG. 4

The diagram, Fig. 1, shows the method of propulsion, contact being made by the key B, so that the armature, P, of the firing relay is in contact with the left terminal, Fig. 1. The current goes principally by the second above-enumerated ways, which is that which offers the least resistance to the motor and without actuating the electromagnet, Q Q^1, acts upon the motor which puts in motion the screw of the torpedo, giving the torpedo a velocity of from 20 to 22 knots. This can be modified at the will of the operator, and the direction of the torpedo can be modified by actuating the relay and the rudder as previously described.

THE MIDGET ARC LAMP.

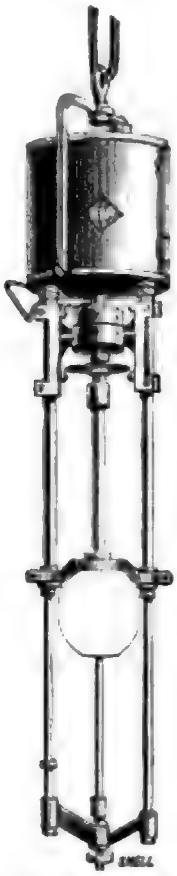
The great economy of arc as compared with incandescent lighting renders interesting any attempt to popularise the use of small arc lamps. For large shops or small lecture theatres something between the usual large arc and the ordinary incandescent lamp has long been wanted. It is absolutely necessary, not only that these small lamps should possess perfect steadiness, but also that they should be so simple in construction that they may be relied on for keeping in working order without constant skilled attention.

A lamp which fulfils these conditions is now being introduced by Messrs. Woodhouse and Rawson. It is called the "Midget," from its small size, and is made to give 250 c.p., using 5 amperes at an E.M.F. of 45 volts, so that even with this small size of lamp we obtain 1 c.p. of light for the expenditure of every "watt" of electrical energy used.

The illustration shows the general appearance of the lamp. The smallness of the globe prevents any depth of shadow, and minimises any complaint which may be urged against the inequality of the distribution of the light.

The principle upon which the lamp works may almost be called simplicity itself. The upper part of the rods forming the frame of the lamp are hollow, and in these the lower portions slide quite easily. The bottom carbon is attached to the lower part of the frame, which is fastened to the upper portions of the lamp by a chain passing up the hollow pillar forming the upper portion of the lamp, round a pulley-wheel, whose motion is controlled by clockwork, and then to the upper carbon-holder, which acts as a counterpoise and slides freely between the hollow pillars forming the frame of the lamp.

The motion of the pulley is controlled by clockwork, which is started and stopped by a pivoted bar, on whose under surface a number of teeth are situated. These engage a pointer attached to the pendulum of the clock. This bar is pivoted in the centre, and attached each end to iron plungers which move inside the cores of electromagnets actuated respectively by the main and shunt circuits. When, owing to the distance between the carbon points, the resistance of the main circuit increases, and consequently the current through the shunt increases, the plunger is drawn further into the core round which the shunt circuit passes and the pendulum is released; the clockwork moves the carbons nearer together until the main circuit increases so much as to draw the other plunger into the core round which it passes, and so overpowers the effect of the shunt circuit. The bar is drawn down, the teeth engage the pendulum of the clockwork, and the carbons are maintained apart until, owing to the burning away, the same action is repeated. This action is so delicate that no inconvenience at all is caused by the intermittent feed—indeed, it is scarcely noticed.


The Midget Arc Lamp.

When the current is stopped the pendulum is released, owing to the action of a spring upon the bar, and the clockwork causes the carbons to remain together.

In the small box over the upper carbon-holder, the current, before passing to the carbon, magnetises an iron core, and lifts the upper carbon a small distance above the lower one, and thus forming the arc when the current is first put on the lamp. The carbon is held up in this manner all the time the current is passing through the lamp. The lamp in wound in three different ways—one suitable for parallel working, one for series, and one for use with alternating currents.

ELECTRIC LIGHT ON SHIPBOARD.*

SYSTEMS OF WIRING.

Electric light being now an absolute necessity on a large proportion of the mercantile as well as the fighting navies of the world, and a knowledge of the requirements connected with its use having hitherto been almost entirely confined to the specialists by whom it is installed, we have thought that shipowners would be glad of a short statement, given as far as possible in non-technical language, of the methods adopted for the wiring of their boats, and the precautions necessary to guard against the occurrence of fires. As a preliminary to this statement, however, it will be well to point out the place occupied by the wiring in regard to the whole installation. A system of electric lighting is not analogous to a system of gas lighting. In the latter case, the current of gas has to be conveyed from the source of supply to the illuminating flame, after leaving which, in a changed condition, it is generally left to poison the atmosphere and shift for itself. The electric current, on the other hand, is unchanged in both volume and nature after passing through the lamp, and has to be led back to the dynamo, to be, as it were, again put under pressure for further use. The electric circuit may, as a popular exposition of the subject, be likened to the flow of water round and round in an endless pipe. At one point the pipe is enlarged to receive a pump, and at other points is obstructed, say, by pieces of sponge or porous stone, to force the full body of water, through which great pressure has to be exerted by the pump. In the electric analogue the pump is represented by the dynamo, the pipe by an insulated metal conductor, and the obstructing sponges by the lamps. Certain practical considerations prevent the placing of the lamps all in a row, one after the other, or, as it is termed, "in series," on one circuit, or even on a considerable number of circuits. The arrangement of each circuit is as if two large water mains were carried along the ship, side by side, and connected to the pump, so that water is drawn from one main and delivered into the other. Instead of having their further ends joined together, so as to form one endless pipe, as in our previous supposition, the two mains are connected at intervals, as required, by branch pipes containing sponges. In each of these branch-connecting pipes a tap may be inserted for the purpose of turning the water on or off as required. With this arrangement the pump has to maintain a constant difference of pressure between the two mains, and each sponge passes the proper amount of water, however many or few are in action at once. A sponge in a water-pipe may not at first seem a good simile for a bright light, but on consideration it will be found not inapt. The incandescent or glow lamp (the lamp universally used on board ship, except for special purposes, such as powerful search-lights) owes its brightness to what may be called friction between the electric current and the thin thread of carbon, known as the "filament," along which it has to travel. In this case the conductor is so small and the current so comparatively large that the friction makes the conductor white hot. The light then is merely an incidental effect due to a thin strip of carbon being heated. Now, though the sponge in the water-pipe does not become white hot and give light, the difference in effect is only in degree; the sponges, water, and pipes do become warmed in proportion to the work done in forcing the water through its circuit, just as the lamp filament and conducting mains become warmed in proportion to the work done in forcing the electric current through them. In the former case a large mass of matter is heated to a small extent, while in the latter the effect is concentrated on a very small mass of matter, which, therefore, is intensely heated. The conducting wires may, we see now, be for practical purposes considered as acting the part of pipes, and the lamps as obstructions in them; for, more correctly, the indiarubber or other insulation surrounding the wire acts the part of the metal in the pipe, and the conductor in the centre acts as the hollow space inside the pipe. The nature of electric currents—if currents they really are—and why they can pass through a dense metal like copper six times as easily as through iron, or nine thousand million million

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* From the *Liverpool Journal of Commerce.*

million times as easily as through indiarubber, are unsolved mysteries. The practical outcome of the foregoing considerations is that three methods of wiring on shipboard have been worked out. These are known respectively as "single," "double," and "concentric" wiring. In single wiring the hull of the ship forms the return conductor from the lamps to the dynamo; a conductor being led from every lamp to the ironwork of the hull. In double wiring the current is not allowed to enter the hull of the ship at all, but returns to the dynamo through an insulated main, being in all respects analogous to the hydraulic system sketched above. Concentric wiring is also a double wiring, but one conductor is throughout enclosed in the other, with the insulating indiarubber in between. With any of these systems good results so far as regards the lighting of the boat may be obtained. We would, however, most strongly urge that whatever system may be adopted, the work and materials must be of the highest class if a thoroughly good and lasting installation is to be had. If the work is well designed and carried out, little or no trouble should be experienced for years; whereas, if the materials are flimsy, or the workmanship hurried, continual cutting out and patching up will be required almost from the first, to say nothing of fire risks. The simple acceptance of the lowest tender for an installation, without some guarantee of high-class work, is very bad economy indeed. For some time now the single-wire system has been used very extensively, and it would probably have continued in favour but for the fact that Sir William Thomson has delivered its death-blow on account of its influence on compasses, as will be seen from the following extract from the *Electrical Review* of May 8 last: "In his lecture on 'Electric and Magnetic Screening,' at the Royal Institution, Sir William Thomson condemned the use of the 'single-wire' system of lighting ships by electricity on the ground that observation has shown it to produce an error in the ship's compass of 3deg. to 7deg., every care being taken . . . . the complete two-conductor system." Commenting on the last sentence of the above, Sir William Thomson, in the *Electrical Review* of another date, says: "We see, then, that on account of the compasses it is necessary that the dynamos shall not be capable of causing currents to flow through the hull of the ship at any considerable distance beyond the dynamo-room." The advantages pertaining to double wiring are that compasses are unaffected, and that a double thickness of insulation intervenes between the wires to prevent leakage or short circuits. The disadvantages are that there are two conductors to be provided and separately insulated and protected. The installation of the electric light on shipboard involves the overcoming of far greater difficulties than are met with under ordinary circumstances on shore; the great changes of temperature, the constant straining and vibration, the salt sea air, and the ever-present and insidious moisture—that great enemy of insulation—together form a vigilant body of foemen, ever ready to defeat the efforts of the electrician, if only he can be caught sleeping. How, then, are these special dangers to be best guarded against? In the first place, the insulation on the wires must be of a high class, and thoroughly protected from mechanical injury; then means should as far as possible be provided for preventing any strain from coming on the copper conductor inside, more particularly at the joints. Copper used for electric light leads is of a hard, springy nature, and far more easily broken by bending than the soft copper wire with which everyone is familiar. Joints should be as few in number as practicable, and great care must be exercised in making good where the insulating material has been cut away for the purpose of jointing, and in vulcanising the freshly applied indiarubber. Cut-outs must be introduced wherever a reduction in size of wire occurs. It is a good rule to have no wire smaller than No. 15 standard wire gauge (or a stranded conductor of No. 22 is better), and cut-outs are then required in the proportion of one to about every 12 lights. The connections with lamp fittings, switches, and cut-outs require special attention. These are generally made (the smaller sizes in particular) by clamping the bare ends of the conductors under the heads of ridiculously little binding screws, which are left free to shake loose or not, as fate may determine. Considering the large number of these connections, it is a pity that some more substantial and quickly-manipulated coupling is not used.

[We imagine that the coupling as described and illustrated in our description of the lighting of the "Scot," is just the one required.—Ed. *E.E.*]

EXPERIMENTS WITH ALTERNATE CURRENTS OF VERY HIGH FREQUENCY AND THEIR APPLICATION TO METHODS OF ARTIFICIAL ILLUMINATION.*

BY NIKOLA TESLA.

(Continued from page 113.)

By preventing completely the exchange of the air molecules, the local heating effect may be so exalted as to bring a body to incandescence. Thus, for instance, if a small button, or preferably a very thin wire or filament, be enclosed in an unexhausted globe and connected with the terminal of the coil, it may be rendered incandescent. The phenomenon is made much more interesting by the rapid spinning round in a circle of the top of the filament, thus presenting the appearance of a luminous funnel, Fig. 16, which widens when the potential is increased. When the potential is small the end of the filament may perform irregular motions, suddenly changing from one to the other, or it may describe an ellipse; but when the potential is very high it always spins in a circle; and so does generally a thin straight wire attached freely to the terminal of the coil. These motions are, of course, due to the impact of the molecules, and the irregularity in the distribution of the potential, owing to the roughness and dissymmetry of the wire or filament. With a perfectly symmetrical and polished wire such motions would probably not occur. That the motion is not likely to be due to other causes is evident from the fact that it is not of a definite direction, and that in a very highly-exhausted globe it ceases altogether. The possibility of bringing a body to incandescence in an unexhausted globe, or even when not at all enclosed, would seem to afford a possible way of obtaining light effects, which, in perfecting methods of producing rapidly alternating potentials, might be rendered available for useful purposes.

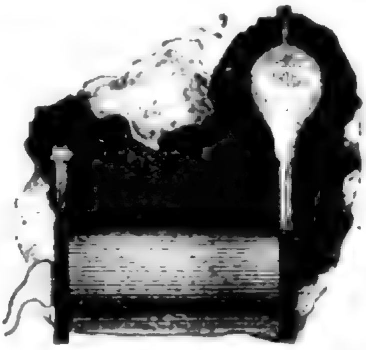

Fig. 16.

In employing a commercial coil, the production of very powerful brush effects is attended with considerable difficulties, for when these high frequencies and enormous potentials are used, the best insulation is apt to give way. Usually the coil is insulated well enough to stand the strain from convolution to convolution, since two double silk-covered paraffined wires will withstand a pressure of several thousand volts; the difficulty lies principally in preventing the breaking through from the secondary to the primary, which is greatly facilitated by the streams issuing from the latter. In the coil, of course, the strain is greatest from section to section, but usually in a larger coil there are so many sections that the danger of a sudden giving way is not very great. No difficulty will generally be encountered in that direction, and, besides, the liability of injuring the coil internally is very much reduced by the fact that the effect most likely to be produced is simply a gradual heating, which, when far enough advanced, could not fail to be observed. The principal necessity is then to prevent the streams between the primary and the tube, not only on account of the heating and possible injury, but also because the streams may diminish very considerably the potential difference available at the terminals. A few hints as to how this may be accomplished will probably be found useful in most of these experiments with the ordinary induction coil.

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* Lecture delivered before the American Institute of Electrical Engineers at Columbia College, New York, May 20.

One of the ways is to wind a short primary, Fig. 17A, so that the difference of potential is not at that length great enough to cause the breaking forth of the streams through the insulating tube. The length of the primary should be determined by experiment. Both the ends of the coil should be brought out on one end through a plug of insulating material fitting in the tube as illustrated. In such a disposition one terminal of the secondary is attached to a body the surface of which is determined with the greatest care so as to produce the greatest rise in the potential. At the other terminal a powerful brush appears, which may be experimented upon.

The above plan necessitates the employment of a primary of comparatively small size, and it is apt to heat when powerful effects are desirable for a certain length of time. In such a case it is better to employ a larger coil, Fig. 17B, and introduce it from one side of the tube, until the streams begin to appear. In this case the nearest terminal of the secondary may be connected to the primary or to the ground, which is practically the same thing, if the primary is connected directly to the machine. In the case of ground connections it is well to determine experimentally the frequency which is best suited under the conditions of the test. Another way of obviating the streams, more or less, is to make the primary in sections and supply it from separate well-insulated sources.

In many of these experiments, when powerful effects are wanted for a short time, it is advantageous to use iron cores with the primaries. In such case a very large primary coil may be wound and placed side by side with the secondary, and, the nearest terminal of the latter being connected to the primary, a laminated iron core is introduced through the primary into the secondary as far as the streams will permit. Under these conditions an excessively powerful brush, several inches long, which may be appropriately called "St. Elmo's hot fire," may be caused to appear at the other terminal of the secondary, producing striking effects. It is a most powerful ozoniser, so powerful, indeed, that only a few minutes are sufficient to fill the whole room with the smell of ozone, and it undoubtedly possesses the quality of exciting chemical affinities.

For the production of ozone, alternating currents of very high frequency are eminently suited, not only on account of the advantages they offer in the way of conversion but also because of the fact of the ozonising action of a discharge is dependent on the frequency as well as on the potential, this being undoubtedly confirmed by observation.

In these experiments if an iron core is used it should be carefully watched, as it is apt to get excessively hot in an incredibly short time. To give an idea of the rapidity of the heating, I will state that by passing a powerful current through a coil with many turns, the inserting within the same of a thin iron wire for no more than one second's time is sufficient to heat the wire to something like 100deg. C.

But this rapid heating does not need to discourage us in the use of iron cores in connection with rapidly alternating currents. I have for a long time been convinced that in the industrial distribution by means of transformers, some such plan as the following might be practicable. We may use a comparatively small iron core, subdivided, or perhaps not even subdivided. We may surround this core with a considerable thickness of material which is fireproof and conducts the heat poorly, and on top of that we may place the primary and secondary windings. By using either higher frequencies or greater magnetising forces, we may by hysteresis and eddy currents heat the iron core so far as to bring it nearly to its maximum permeability, which, as Hopkinson has shown, may be as much as 16 times greater than that at ordinary temperatures. If the iron core were perfectly enclosed it would not be deteriorated by the heat, and, if the enclosure of fireproof material would be sufficiently thick, only a limited amount of energy could be radiated in spite of the high temperature. Transformers have been constructed by me on that plan, but for lack of time no thorough tests have as yet been made.

Another way of adapting the iron core to rapid alternations, or, generally speaking, reducing the frictional losses, is to produce by continuous magnetisation a flow of something like 7,000 or 8,000 lines per square centimetre through the core, and then work with weak magnetising forces and preferably high frequencies around the point of greatest permeability. A higher efficiency of conversion and greater output are obtainable in this manner. I have also employed this principle in connection with machines in which there is no reversal of polarity. In these types of machines, as long as there are only few pole projections, there is no great gain, as the maxima and minima of magnetisation are far from the point of maximum permeability; but when the number of the pole projections is very great, the required rate of change may be obtained, without the magnetisation varying so far as to depart greatly from the point of maximum permeability, and the gain is considerable.

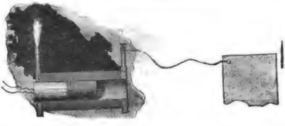

FIG. 17A.

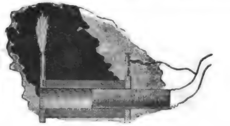

FIG. 17B

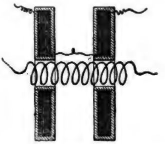

FIG. 18.

The above described arrangements refer only to the use of commercial coils as ordinarily constructed. If it is desired to construct a coil for the express purpose of performing with it such experiments as I have described, or, generally, rendering it capable of withstanding the greatest possible difference of potential, then a construction as indicated in Fig 18 will be found of advantage. The coil in this case is formed of two independent parts which are wound oppositely, the connection between both being made near the primary. The potential in the middle being zero, there is not much tendency to jump to the primary, and not much insulation is required. In some cases the middle point may, however, be connected to the primary or to the ground. In such a coil the places of greatest difference of potential are far apart and the coil is capable of withstanding an enormous strain. The two parts may be movable so as to allow a slight adjustment of the capacity effect.

As to the manner of insulating the coil, it will be found convenient to proceed in the following way: First, the wire should be boiled in paraffin, until all the air is out; then the coil is wound by running the wire through melted paraffin, merely for the purpose of fixing the wire. The coil is then taken off from the spool, immersed in a cylindrical vessel filled with pure melted wax, and boiled for a long time until the bubbles cease to appear. The whole is then left to cool down thoroughly, and then the mass is taken out of the vessel and turned up in a lathe. A coil made in this manner and with care is capable of withstanding enormous potential differences.

It may be found convenient to immerse the coil in paraffin oil or some other kind of oil; it is a most effective way of insulating, principally on account of the perfect exclusion of air, but it may be found that, after all, a vessel filled with oil is not a very convenient thing to handle in a laboratory. If an ordinary coil can be dismounted, the primary may be taken out of the tube and the latter plugged up on one end, filled with oil, and the primary reinserted. This affords an excellent insulation, and prevents the formation of the streams.

Of all the experiments which may be performed with rapidly alternating currents, the most interesting are those which concern the production of a practical illuminant. It cannot be denied that the present methods, though they were brilliant advances, are very wasteful. Some better methods must be invented, some more perfect apparatus devised. Modern research has opened new possibilities for the production of an efficient source of light, and the attention of all has been turned in the direction indicated by able pioneers. Many have been carried away by the enthusiasm and passion to discover, but in their zeal to reach results, many have been misled. Starting with the idea of producing electromagnetic waves, they turned their attention, perhaps, too much to the study of electromagnetic effects, and neglected the study of electrostatic phenomena. Naturally, nearly every investigator availed himself of an apparatus similar to that used in earlier experiments. But in those forms of apparatus, while the electromagnetic inductive effects are enormous, the electrostatic effects are excessively small.

In the Hertz experiments, for instance, a high-tension induction coil is short-circuited by an arc, the resistance of which is very small, the smaller the more capacity is attached to the terminals; and the difference of potential at these is enormously diminished. On the other hand, when the discharge is not passing between the terminals, the static effects may be considerable, but only qualitatively so, not quantitatively, since their rise and fall is very sudden, and since their frequency is small. In neither case, therefore, are powerful electrostatic effects perceivable. Similar conditions exist when, as in some interesting experiments of Dr. Lodge, Leyden jars are discharged disruptively. It has been thought—and I believe asserted—that in such cases most of the energy is radiated into space. In the light of the experiments which I have described above, it will now not be thought so. I feel safe in asserting that in such cases most of the energy is partly taken up and converted into heat in the arc of the discharge and in the conducting and insulating material of the jar, some energy being, of course, given off by electrification of the air; but the amount of the directly radiated energy is very small.

When a high-tension induction coil, operated by currents alternating only 20,000 times a second, has its terminals closed through even a very small jar, practically all the energy passes through the dielectric of the jar, which is heated, and the electrostatic effects manifest themselves outwardly only to a very weak degree. Now the external circuit of a Leyden jar—that is, the arc and the connections of the coatings—may be looked upon as a circuit generating alternating currents of excessively high frequency and fairly high potential, which is closed through the coatings and the dielectric between them, and from the above it is evident that the external electrostatic effects must be very small, even if a recoil circuit be used. These conditions make it appear that with the apparatus usually at hand the observation of powerful electrostatic effects was impossible, and what experience has been gained in that direction is only due to the great ability of the investigators.

But powerful electrostatic effects are a *sine qua non* of light production on the lines indicated by theory. Electromagnetic effects are primarily unavailable, for the reason that to produce the required effects we would have to pass current impulses through a conductor which, long before the required frequency of the impulses could be reached, would cease to transmit them. On the other hand, electromagnetic waves many times longer than those of light, and producible by sudden discharges of a condenser, could not be utilised, it would seem, except we avail ourselves of their effect upon conductors as in the present methods, which are wasteful. We could not affect by means of such waves the static molecular or atomic charges of a gas, cause them to vibrate and to emit light. Long transverse waves cannot, apparently, produce such effects, since excessively small electromagnetic disturbances may pass readily through miles of air. Such dark waves, unless they are of the length of true light waves, cannot, it would seem, excite luminous radiation in a Geissler tube, and the luminous effects which are producible by induction in a tube devoid of electrodes, I am inclined to consider as being of an electrostatic nature.

To produce such luminous effects, straight electrostatic thrusts are required; these, whatever be their frequency, may disturb the molecular charges and produce light. Since current impulses of the required frequency cannot pass through a conductor of measurable dimensions, we must work with a gas, and then the production of powerful electrostatic effects becomes an imperative necessity.

It has occurred to me, however, that electrostatic effects are in many ways available for the production of light. For instance, we may place a body of some refractory material in a closed, and preferably more or less exhausted, globe, connect it to a source of high, rapidly alternating, potential causing the molecules of the gas to strike it many times a second at enormous speeds, and in this manner, with trillions of invisible hammers, pound it until it gets incandescent; or we may place a body in a very highly-exhausted globe, in a non-striking vacuum, and by employing very high frequencies and potentials transfer sufficient energy from it to other bodies in the vicinity, or in general to the surroundings, to maintain it at any degree of incandescence, or we may, by means of such rapidly alternating high potentials, disturb the ether carried by the molecules of a gas or their static charges, causing them to vibrate and to emit light. But, electrostatic effects being dependent upon the potential and frequency, to produce the most powerful action it is desirable to increase both as far as practicable. It may be possible to obtain quite fair results by keeping either of these factors small, provided the other is sufficiently great; but we are limited in both directions. My experience demonstrates that we cannot go below a certain frequency, for, first, the potential then becomes so great that it is dangerous; and, secondly, the light production is less efficient.

I have found that, by using the ordinary low frequencies, the physiological effect of the current required to maintain at a certain degree of brightness a tube 4ft. long, provided at the ends with outside and inside condenser coatings, is so powerful that, I think, it might produce serious injury to those not accustomed to such shocks; whereas, with 20,000 alternations per second, the tube may be maintained at the same degree of brightness without any effect being felt. This is due principally to the fact that a much smaller potential is required to produce the same light effect, and also to the higher efficiency in the light production. It is evident that the efficiency in such cases is the greater, the higher the frequency, for the quicker the process of charging and discharging the molecules, the less energy will be lost in the form of dark radiation. But, unfortunately, we cannot go beyond a certain frequency on account of the difficulty of producing and conveying the effects.

I have stated above that a body enclosed in an unexhausted bulb may be intensely heated by simply connecting it with a source of rapidly alternating potential. The heating in such a case is, in all probability, due mostly to the bombardment of the molecules of the gas contained in the bulb. When the bulb is exhausted the heating of the body is much more rapid, and there is no difficulty whatever in bringing a wire or filament to any degree of incandescence by simply connecting it to one terminal of a coil of the proper dimensions. Thus, if the well-known apparatus of Prof. Crookes, consisting of a bent platinum wire with vanes mounted over it, Fig. 19, be connected to one terminal of the coil—either one or both ends of the platinum wire being connected—the wire is rendered almost instantly incandescent, and the mica vanes are rotated as though a current from a battery were used. A thin carbon filament, or preferably a button of some refractory material, Fig. 20, even if it be a comparatively poor conductor, enclosed in an exhausted globe, may be rendered highly incandescent; and in this manner a simple lamp capable of giving any desired candle-power is provided.

The success of lamps of this kind would depend largely on the selection of the light-giving bodies contained within the bulb. Since, under the conditions described, refractory bodies—which are very poor conductors and capable of withstanding for a long time excessively high degrees of temperature—may be used, such illuminating devices may be rendered successful.

It might be thought at first that if the bulb containing the filament or button of refractory material, be perfectly well exhausted—that is, as far as it can be done by the use of the best apparatus—the heating would be much less intense, and that in a perfect vacuum it could not occur at all. This is not confirmed by my experience; quite the contrary, the better the vacuum the more easily the bodies are brought to incandescence. This result is interesting for many reasons.

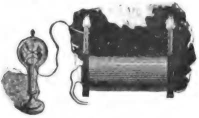

FIG. 19.

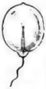

FIG. 20.

At the outset of this work, the idea presented itself to me whether two bodies of refractory material enclosed in a bulb exhausted to such a degree that the discharge of a large induction coil, operated in the usual manner, cannot pass through, could be rendered incandescent by mere condenser action. Obviously, to reach this result, enormous potential differences and very high frequencies are required, as is evident from a simple calculation.

But such a lamp would possess a vast advantage over an ordinary incandescent lamp in regard to efficiency. It is well known that the efficiency of a lamp is to some extent a function of the degree of incandescence, and that, could we but work a filament at many times higher degrees of incandescence, the efficiency would be much greater. In an ordinary lamp this is impracticable on account of the destruction of the filament, and it has been determined by experience how far it is advisable to push the incandescence. It is impossible to tell how much higher efficiency could be obtained if the filament could withstand indefinitely, as the investigation to this end obviously cannot be carried beyond a certain stage; but there are reasons for believing that it would be very considerably higher. An improvement might be made in the ordinary lamp by employing a short and thick carbon; but then the leading-in wires would have to be thick, and, besides, there are many other considerations which render such a modification entirely impracticable. But in a lamp as above described the leading-in wires may be very small, the incandescent refractory material may be in the shape of blocks offering a very small radiating surface, so that less energy would be required to keep them at the desired incandescence; and, in addition to this, the refractory material need not be carbon, but may be manufactured from mixtures of oxides, for instance, with carbon or other material, or may be selected from bodies which are practically non-conductors, and capable of withstanding enormous degrees of temperature.

All this would point to the possibility of obtaining a much higher efficiency with such a lamp than is obtainable in ordinary lamps. In my experience it has been demonstrated that the blocks are brought to high degrees of incandescence with much lower potentials than those determined by calculation, and the blocks may be set at greater distances from each other. We may freely assume, and it is probable, that the molecular bombardment is an important element in the heating, even if the globe be exhausted with the utmost care as I have done; for although the number of the molecules is, comparatively speaking, insignificant, yet on account of the mean free path being very great, there are fewer collisions, and the molecules may reach much higher speeds, so that the heating effect due to this cause may be considerable, as in the Crookes experiments with radiant matter.

But it is likewise possible that we have to deal here with an increased facility of losing the charge in very high vacuum, when the potential is rapidly alternating, in which case most of the heating would be directly due to the surging of the charges in the heated bodies. Or else the observed fact may be largely attributable to the effect of the points which I have mentioned above, in consequence of which the blocks or filaments contained in the vacuum are equivalent to condensers of many times greater surface than that calculated from their geometrical dimensions. Scientific men still differ in opinion as to whether a charge should, or should not, be lost in a perfect vacuum, or, in other words, whether ether is, or is not, a conductor. If the former were the case, then a thin filament enclosed in a perfectly exhausted globe, and connected to a source of enormous, steady potential, would be brought to incandescence.

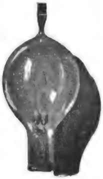

FIG. 21.

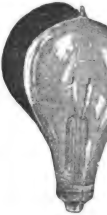

FIG. 22.

Various forms of lamps on the above-described principle, with the refractory bodies in the form of filaments, Fig. 21, or blocks, Fig. 22, have been constructed and operated by me, and investigations are being carried on in this line. There is no difficulty in reaching such high degrees of incandescence that ordinary carbon is to all appearance melted and volatilised. If the vacuum could be made absolutely perfect, such a lamp, although inoperative with apparatus ordinarily used, would, if operated with currents of the required character, afford an illuminant which would never be destroyed, and which would be far more efficient than an ordinary incandescent lamp. This perfection can, of course, never be reached, and a very slow destruction and gradual diminution of the size always occurs, as in incandescent lamps; but there is no possibility of a sudden and premature disabling which occurs in the latter by the breaking of the filament, especially when the incandescent bodies are in the shape of blocks.

(*To be continued.*)

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PREVENTION BETTER THAN CURE.

The recent railway accident at Paris, in which one train telescoped another, and in which more persons probably were indirectly killed or injured than directly, has brought about a suggestion worthy of careful consideration by our railway authorities. In the accident referred to, the carriages were set on fire either by the coal from the engine fire, by the gas used for lighting, or by both. The danger from the coal of the engine is more remote in accidents of the kind than the danger from the gas. It has been pointed out that if trains were generally lighted by electricity, the chance of carriages catching fire in an accident would be very small. Certainly there would be less danger with electricity than with gas; but railway managers are only slowly realising the old axiom that prevention is better than cure. The railway era commenced with open trucks for passengers, with carriages built upon the plans of the old stage coach—stuffy and uncomfortable. Gradually the passengers were sheltered, and more and more care was taken with signalling apparatus—each move in advance in the latter direction being for the purpose of preventing accidents. The partial block gave way to the absolute block; interlocking points and signals, the abolition of facing points, were one and all moves in the direction of prevention. While improvement was being made in the permanent way, improvement was also going on in regard to the comfort of passengers. The strain upon the physical man during a journey to Antwerp by the Great Eastern Railway, to Edinburgh by the Great Northern, to Leeds by the Midland, to Holyhead by the London and North-Western, to Bristol by the Great Western, is hardly more, if it be as much, than the strain from any suburban retreat requiring three quarters of an hour's journey to the City. Prevention of accident, prevention of discomfort during long journeys, have been constantly moving views with the managers of most of our railway systems. The one weak link seems to have been suburban traffic, and this, especially on the southern lines, is a disgrace to civilisation. It may be asked, however, whether the greatest inducement in the eyes of the managers to improve permanent way and rolling-stock has not been that such improvement pays. The first and ruling passion of a manager is to make his line pay. The suggestion to light railway carriages with electrical apparatus is one we heartily support, in that we imagine it would be an improvement appreciated by the travelling public, would conduce to greater safety and comfort, and, above all, would pay. The *Lancet* has quite recently added its quota of evidence to the view that electricity in workshops and warehouses is healthy; we should like to have its opinion as to the evil effects of train lighting upon the eyes of constant travellers. It is absurd to preach a doctrine of do not read in a train. Business men must read, and travellers on pleasure bent will read. The best method to counteract the evil effect of such reading is to provide plenty of light. Better a superabundance than a lack. It is, then, not so much on account of the less danger when an accident occurs that we advocate the use of electric train-lighting, because we believe the great object is primarily to prevent the accident; but we would have such lighting become general in order to prevent the evils arising from the present system, which consists simply in making darkness visible. What is there to prevent electrical train lighting? It is by no means a difficult problem, and we doubt if it is a more costly one than some of the systems at present in use of lighting by gas.

TRAMWAYS.

It may be remembered that exact figures as to the electrical working of tramways was in a measure promised by the chairman of the Birmingham Central Tramways. This promise has been fulfilled in the tables appended to the report of the directors, given elsewhere. Even these figures are delusive, and the electrical work does not show as well as it will in the future. Difficulties were encountered and had to be overcome, which increases the cost, but it is satisfactory to learn from the report that the profit earned is steadily improving. Care must be taken not to make invidious comparisons between tram lines. It cannot be taken that because a line at one place is satisfactorily worked, a similar line at another place would show similar results. The amount of possible traffic varies in different localities. However, the important point to decide is to find the minimum cost of working under given conditions. The tables referred to analyse the expenses showing the cost per mile run. The totals show cost per mile with steam to be 10·99d.; with horses, 9·79d.; with cables, 6·33d.; and with electricity, 9·90d. Here cable traction shows best, that of electricity and horses being almost the same, while steam is the most costly.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

TOWNLEY'S DUPLEX ALARM.

Sir,—In answer to Mr. Townley's letter of to-day's issue *re* his duplex alarm, I have taken his advice and again taken the trouble to read carefully the description of his alarm given in your paper, and fail to see where the freedom from switches and complicated parts comes in.

If Mr. Townley will now do me the favour to also carefully read both his articles and my own, he will see that his arrangement comprises a bell with five moving parts. In mine there is one. His contacts, P and P^1, are liable to oxidise. With mercury cups bad contact is impossible. He trusts to plain contact in clock. In mine there is a *switch*, with a knife edge lever, which drops into a split pillar, actuated by a spiral spring with a rotary pressure of 2lb.; thus securing a powerful rubbing contact.

He has had his clock and alarm in use for 12 months; I have had mine in use full five years, therefore = five recommendations.

In conclusion, I still fail to see the novelty attached to Townley's duplex alarm.—Yours, etc.,

Norwood, S.E., July 31, 1891. A. McMeekin.

EDISON DYNAMO AND MOTOR.*

It is one thing to make a dynamo or motor from explicit instructions and quite another thing to design a machine adapted to generate or be operated by a particular current. The former is purely mechanical and within the range of most machinists and amateurs, while the latter is entirely within the province of the electrical engineer or electrician. When the work of machine building proceeds simultaneously with the study of fundamental principles, real progress is made. For the benefit of those who proceed in this way, and in answer to many enquirers, we give a detailed description of an Edison ·25-kilowatt machine, designed for use as a dynamo for supplying a current for five Edison standard lamps, or for use on the Edison circuit as a ½-h.p. motor.

Before beginning the description of the machine, it is but fair to say that it is thoroughly well made in every particular. The insulation in every part is very perfect, and the whole is so well made that any single machine built by a mechanic or amateur could but suffer by comparison with it; and, furthermore, we doubt if any maker of a single machine could even purchase the materials required for the price asked for the machine by the regular manufacturers. Therefore, if the machine is wanted, we advise a purchase. If experience is wanted, the making of the machine comes first in order, with a probable purchase to follow.

The engravings are one-sixth the actual size, linear measurement.

The base, which is of brass, is made hollow, as shown. It is 14in. long, 7⅜in. wide, 1¾in. deep at the ends, with two 1⅛in. elevations at the middle for receiving the cast-iron pole-pieces of the field magnet, which are each secured to the base by two small tap bolts extending upwardly through the base and into the pole-pieces.

The upper surfaces of the pole-pieces are truly faced for receiving the cylindrical field magnet cores, which are made of Swedish iron 2⅝in. in diameter and 4½in. long. These magnet cores are each held in position by a threaded stud screwed into the pole-piece and entering magnet core. Each core is provided with a vulcanised fibre collar at each end, which is ¼in. thick and ⅞in. wide. Upon each core, and between the fibre collars, is wound 5¼lb. of No. 24 silk-covered copper wire, with a wrapping of thin varnished paper between the layers. The cores, before winding, are thoroughly insulated with the same material. The fibre collars are each held in place by three conical-headed screws entering the end of the core, with their heads projecting beyond the body of the core. To the inner and outer ends of the winding of each arm of the magnet are attached pieces of larger wire to avoid breakage, and the inner ends are led out through grooves in the fibre collars. The yoke, of Swedish iron, is 2⅝in. wide, 2⅛in. thick, and 7½in. long. It is held in position on the cores by two ½in. bronze studs, each threaded at the upper and lower ends, and furnished with a collar which fits into the counterbored part of the hole in the yoke. The studs are squared at the upper end to receive a wrench, and a nut is placed on each stud above the yoke for clamping it securely after adjustment. The machine is regulated or adapted to any work requiring less than its full power by raising the yoke more or less. The yoke is provided with an eye, by means of which the machine may be lifted.

Front and rear boards of mahogany are arranged on opposite sides of the yoke, and held in place by brass plates at the ends.

The outside ends of the field magnet coils are connected with binding posts on the rear board.

A variable resistance of 10 or 15 ohms is inserted between these posts when the machine is used as a dynamo. In the front board, at the right-hand side, is secured a bronze casting, known as the right-hand motor head field magnet terminal. This is adapted to receive the line wire, also one of the leads, the upper end of which is screwed to the casting. The lower end of the lead is secured to a lead terminal attached to a block of wood secured to the right-hand pole-piece. At the right-hand side of the machine a similar arrangement of the lead is found, but the upper lead terminal is made in two separate parts, one attached to the lead, the other being connected with the line; both being furnished with copper switch tongues. The switch arm turns on a stud projecting from the front board, and carries a loose triangular switch-plate of copper, having a knife-edge which readily enters between the switch tongues. The switch has a T handle of hard rubber, by means of which it is turned. A stop pin projecting from the front board limits the rearward movement of the switch arm.

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* From the *Scientific American.*

Small Edison Dynamo or Motor.

The inside end of the right magnet coil is connected with the right-hand lead, and the inside end of the left-hand magnet coil is connected with the lower half of the left-hand lead terminal.

At opposite ends of the base there are plane surfaces, to which are secured the self-oiling bearings of the armature shaft. Each bearing has a hollow standard furnished with a cap which, together with a cross-piece in the hollow standard, forms a support for the spherical central portion of the bronze sleeve forming the journal box proper.

Side View of Field Magnet, Partly in Section.

This sleeve is shorter than the outer portion of the bearing, and is slotted across the top to allow two brass rings to ride upon the armature shaft. These rings dip in the oil in the hollow standard, and as they revolve carry oil to the shaft in quantities more than sufficient for the purpose of lubrication. The oil is distributed throughout the bearing by means of spiral grooves formed in the inner surface of the journal box. The surplus oil drops back into the hollow standard. A screw plug in the lower portion of the standard allows of the removal of the oil. The bearings at opposite ends of the machine are alike,

Edison Switch.

except that the cast-iron support of the bronze journal box, at the commutator end of the armature, is turned on the inner end to receive the brush yoke.

(To be continued.)

THE ELECTRIC TRANSMISSION OF POWER.*

BY GISBERT KAPP.

Lecture III.

As an example of a large modern transmission plant, I select, for illustration, that erected a few months ago for the Schaffhausen Spinning Mills. This example is not only interesting on account of its magnitude, but because it has been planted, so to say, into the very stronghold of rope transmission—namely, at the Falls of the Rhine, where the last generation of Swiss engineers carried out such admirable work in telodynamic transmission that the present generation can only copy, but cannot improve upon it. And the grand example set by [illegible], Ziegler, and others, on the Rhine has, as a matter of fact, been largely copied at other places. There is hardly a large engineering works in Switzerland or the South of Germany where rope transmission in some form or other will not be found, but the best days of this system are passed. Till recently, rope transmission held the field absolutely, not because it was perfect, but because there was nothing better. Now, however, we have something better in electric transmission, and the flying ropes are being steadily replaced by the electric conductor. In the first place, the capacity of telodynamic transmission to deal with large powers is limited. During last year the Niagara Commission inspected a large number of plants in Europe, and came to the conclusion that 300 h.p. is the very utmost which can be dealt with by a single rope, so that above this power we must employ more ropes with a corresponding complication in the gear. I need hardly say that no such limit exists in electric transmission. But there are other difficulties in connection with ropes. They wear out very fast, their support at the [illegible] stations on the line requires the erection of very heavy and costly structures, and they are largely influenced by climatic changes, causing excessive strains at some times, and slipping at others. These considerations have induced the managers of the Schaffhausen Spinning Mills to adopt electric transmission in the very spot where rope transmission, in years gone by, has received its most perfect development possible.

The situation of the works is shown on the diagram, Fig. 1. The spinning mills are on one side, and the generating station is on the other side of the river, the distance between the two being about 750 yards. In the generating station there is room for five 350-h.p. turbines, of which four are now in place, but of these only two are as yet used in connection with the electric power transmission I am about to describe. The power of these turbines is sold to the Spinning Company at the rate of £4. 10s. per annual horse-power taken off the rope pulleys, Fig. 2. The turbines are horizontal wheels, and their vertical axes are geared by bevel wheels with the rope pulleys, by which motion is conveyed through cotton ropes to the two generating dynamos. The latter are six-pole machines, each designed for an output of 300 amperes at 600 volts, and in regular work these machines are coupled parallel. The machines, and, in fact, the whole installation, with the exception of the hydraulic works, has been designed by Mr. Brown, to whom I am indebted for the particulars I now bring before you. The electrical part of the plant was made and erected by the Oerlikon Engineering Works. The line consists of four cables (each having an area of ·[illegible] of a square inch), and is supported at four intermediate points, besides the supports at the terminals. One of the intermediate supports is the old turbine-house, which in former times was used in connection with the wire rope transmission; the others are towers of iron framework, 46ft. high, one of which is shown to a larger scale in Fig. 1. The span where the line crosses the river is 330ft., and where it passes along the shore of the river the span is 430ft.

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* Cantor lectures delivered before the Society of Arts.

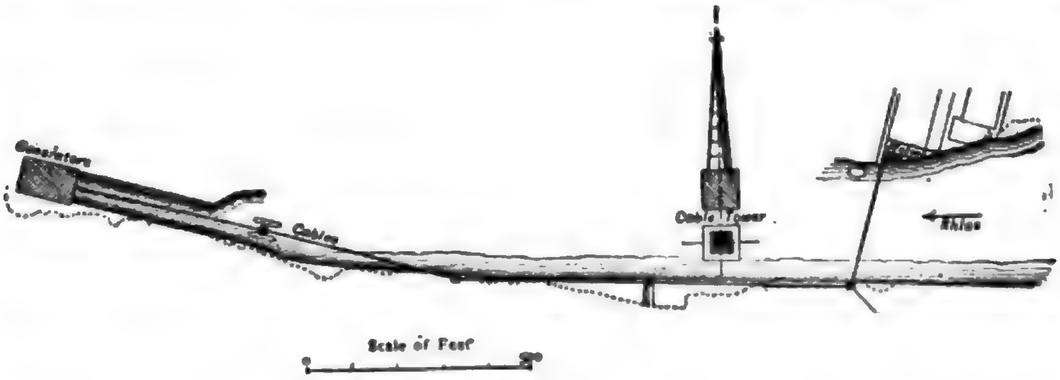

FIG. 1.

You may imagine that the proper support and insulation of cables of that size, and with so long a span, is a matter of considerable difficulty. The use of glass or earthenware insulators on a stalk, as employed for the support of telegraph lines and other light wires, is, of course, out of the question. We must have something very much more substantial, and this has been provided in the manner shown, Fig. 5. Near the top of each post there are bolted to the iron framework four of the boxes shown on this diagram; one for each line of cables. The inner box serves as a kind of junction or connecting piece between the cable ends, which are opened out as shown. Molten zinc is then run in, and surrounds every single wire, thus making a perfect electrical joint; whilst, at the same time, the strain is divided between all the wires in the most even way possible. The inner box is surrounded by an outer box, and the intervening space is cast out with sulphur, which is an excellent insulating material, and applied in this way, of sufficient mechanical strength to resist the large forces involved in the supporting of these heavy cables.

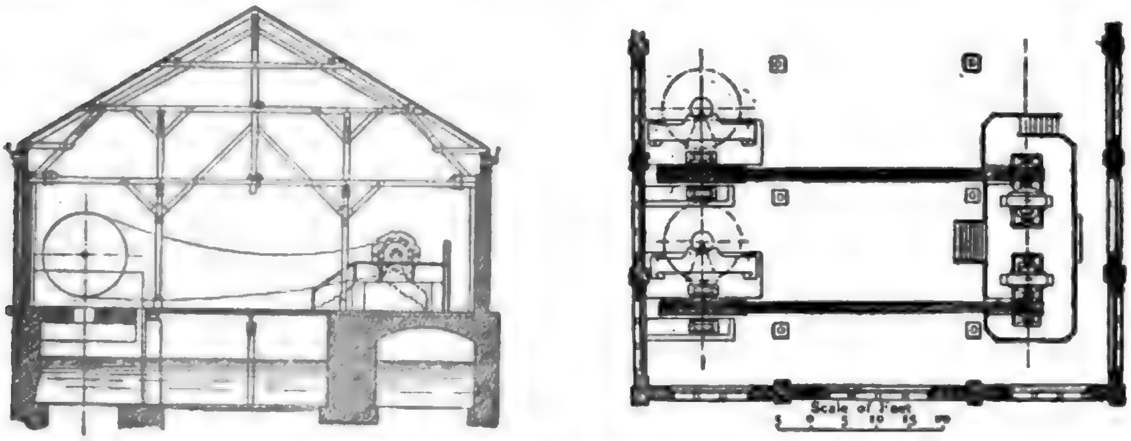

FIG. 2.

In mountainous countries, where thunderstorms are frequent and violent, the protection of lines from lightning strokes is a matter that must not be overlooked. The line I am describing is protected in a twofold manner. In the first place, there is stretched over the four electric cables a steel wire rope, passing right over the supports, and in good electric connection with their iron framework, and, therefore, with earth. The object of this arrangement is to act as an ordinary lightning protector, on the supposition that a lightning flash will rather go to earth by way of the steel cable and one of the towers that run along

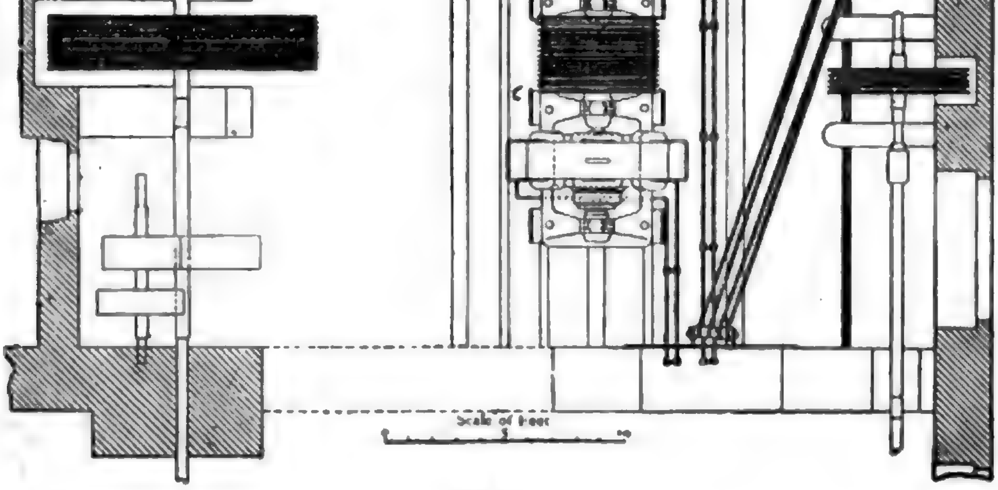

FIG. 3.

the electric line. But lightning flashes are sometimes very erratic, as was shown experimentally in this very room, in the admirable "Mann Lectures" which Prof. Lodge delivered before this society in 1888. It is, therefore, also necessary to make provision for flashes which will, for some reason or other, stray away from the direct path provided for them. And this has been done in the Schaffhausen installation by the employment of lightning arresters at both terminal stations. At each station there are four lightning arresters, one for each cable. They consist of a pair of toothed plates, of which, however, only one is fixed, the other being movable. When a flash strikes one cable only, it goes to earth by the corresponding plates, and no further damage is done. Should, however, both a positive and a negative cable be struck at the same time, then the arc set up between the plates by the passage of the lightning flash provides an easy path for the passage of the power current also; in other words, the generator will be short-circuited. The object of making one of the plates movable is to cut off the short-circuit current before any harm is done to the machinery. The movable plate of the lightning protector is connected to the core of a solenoid, through which the short-circuited current must flow. Immediately this current is started, the core is sucked in, and the movable plate falls away from the fixed plate, thus acting the part of an automatic switch.

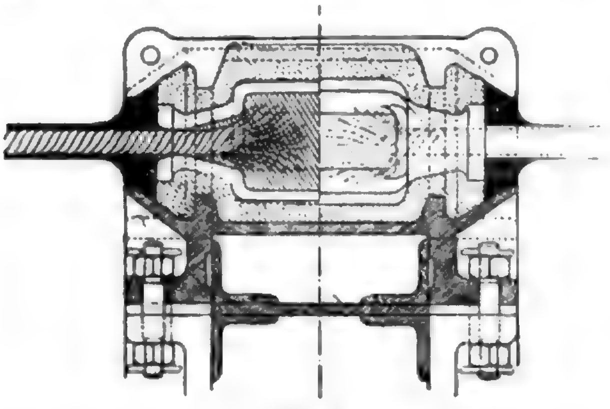

Fig. 5.

Returning now to the Schaffhausen plant, the generating station contains two 300-h.p. dynamos, which are over-compounded, so as to produce a constant pressure of 600 volts at the motor station, the loss in the line being with full current 24 volts. These machines have series-wound drum armatures, running at 200 revolutions per minute. Their more important electrical data, as well as those referring to the motors, are given in the following table:

SCHAFFHAUSEN TRANSMISSION PLANT.

	Generators.	Twin motor.	Small motors.
Number of machines	2	1	2
Normal horse-power	300	380	60
Number of poles in magnet field	6	6	2
Revolutions per minute	300	300	350
Terminal voltage	624	600	600
Normal current, amperes	330	500	81
Diameter of armature, inches	47½	42½	23⅝
Length of armature core, inches	20	20⅝	22½
Radial depth of armature core, inches	8	7	4¾
Section of armature conductor, square inches	·103	·078	·0287
Number of armature conductors	316	316	540
Number of commutator segments	153	153	90
Loss in armature resistance per cent.	1·46	1·52	2·7
Induction in armature C.G.S. measure	7,500	7,600	15,800
Shunt resistance ohms	140	143	295
Loss in shunt excitation per cent.	1·35	1·68	—
Main turns per magnet	6	4	—
Loss in main excitation per cent.	3	2	—
Type of armature	Drum	Drum	Cylinder

Fig. 3 shows the twin motor, which receives the bulk of the power at the spinning mills, whilst the remainder is taken up by a couple of two-pole motors, placed in other parts of the mills. These are not shown on the diagrams, as they are of the ordinary design, with which you are already familar. The twin motor is rated at 380, and each of the single motors at 60 h.p., making in all 500 net brake horse-power delivered to the mill shafting. The coupling between the motors and the mill shafting is by cotton ropes, as shown in Fig. 3, the arrangement chosen having the advantage that very little side strain is thrown upon the motor bearings, owing to the ropes pulling opposite ways.

An interesting and novel feature of the plant is the arrangement adopted for starting gradually, and yet without the use of resistance. In my experiments last week I used current delivered at constant pressure; and to start the motor gradually and prevent sparking at the commutator, I was obliged to insert into the armature circuit a variable resistance, which was withdrawn after the motor had gathered enough speed to make this safe. There is no inconvenience in using such a resistance when we are dealing with small currents; but when it is a question of several hundred amperes and the absorption of as many horse-power, the resistance becomes a very cumbersome and unwieldy appliance. To get over this difficulty, Mr. Brown has devised a very ingenious method of coupling between the line and machines, the essential features of which are shown in Fig. 6. As I have already mentioned, there are four main cables—two positive and two negative. Three of these cables contain no switches which need be used for starting, although, of course, they contain the switches and fuses which may be required for testing purposes and as safety devices, but these not being essential to the explanation of the starting arrangements, I have not shown in the diagram. Call the two outer cables positive, and the two inner cables negative. The positive cables are looped at both terminuses, and the inner cables are also looped in this way, but a switch is inserted in the right-hand cable at the motor station. Now imagine all the machines at rest, and this switch to be open. To start the plant, the turbine-driven generator, G_1, is set in motion, and the speed run up till this machine excites itself by its own shunt. If you follow the connections you will find that the shunts of the other three machines will at the same time also become excited. The motors have now made their fields, and if we start the second generator, G_2, slowly, a power current of gradually increasing strength will be sent through both motors, and the latter will gradually start. As they gather speed, their counter E.M.F., which is indicated by a voltmeter at the motor station, gradually rises; and if it has become equal to the E.M.F. indicated by a second voltmeter in connection with the current from the first generator, G_1, the attendant closes the switch, and the operation of starting is completed. It should be noted that on closing this switch there is no sudden rush of current, since the pressure on both sides of the switch is approximately equal.

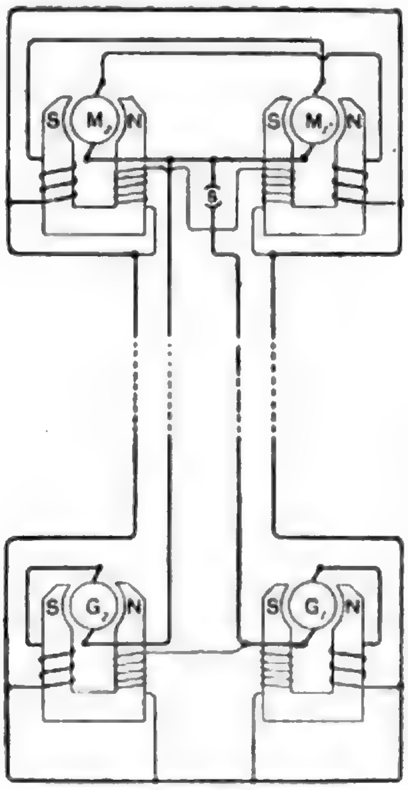

Fig. 6.

Originally, the motors were intended to be pure shunt machines; but it was soon found that, owing to the very small armature resistance and armature reaction, it was very difficult to get the load equally divided between them. Mr. Brown, to overcome this difficulty, hit upon the ingenious device of making the machines mutually control each other by putting on demagnetising main coils, and crossing the connections between armatures and fields, so that the machine which might at any moment develop a tendency to take more than its fair share of current would have its field strengthened by the deficiency of current passing through its main turns to the other armature, and would thus immediately raise its counter E.M.F., and check the excess of current, whilst the other machine which was not taking enough current would have its field weakened, and would thus be forced to take more current. It is clear that by this cross-connection even a neglect on the part of the attendant to set the brushes properly cannot materially influence the even division of current and load between the two machines. At the same time the demagnetising influence of the main coils has the same effect as if the armature reaction were increased, and ensures thus constancy of speed, as I have shown you experimentally last week. In the diagram, Fig. 6, the machines are represented as if they had only two poles each. This I have done to make the diagram as simple as possible, and for the same reason I have shown the shunt and main coils on separate magnet limbs, but you will have no difficulty in translating in your own mind this principle of circuit connections to multipolar machines.

It may interest you to have a few details of a commercial nature regarding this transmission plant. The manufacturers have guaranteed a commercial efficiency at ordinary full load of 78 per cent., also that the machines must be capable of transmitting an excess of 20 per cent. over their normal power for one hour and a half without damage. The wear of one set of brushes to be not less than 2,000 hours, and the life of a commutator not less than 20,000 hours. The variation of speed of the motors between running idle and under full load not to exceed 3 per cent. The total cost of the electrical part of the plant, including cable towers and erection, was £6,800, or £13. 12s. per net horse-power delivered.

I have occupied some time in putting before you this transmission plant, because exact information about successful engineering work is of great value to practical men; and the Schaffhausen plant is certainly one of the best and most successful examples I could have chosen. The power transmitted is certainly large, according to our present ideas, but there is good reason to believe that—in point of magnitude, at any rate—this transmission will very soon be eclipsed by other work of this kind. There are projects afloat for utilising the power of the Rhine, near Bâle, to the tune of tens of thousands of horse-power, and at Niagara, as you all know, a total of 125,000 h.p., or a little over 3¼ per cent. of the total power of Niagara, is to be taken from the Falls and transmitted to various distances, the longest distance being some 20 miles. I am not in a position to give you details of any of the schemes which have been submitted to the Niagara Commission, since these are the property of the Cataract Company, but by the courtesy of several members of the Commission, notably Dr. Coleman Sellers, I am able to give you a general outline of the schemes. My object in applying to the Niagara Commission for information of this kind was to obtain some indication of the opinions which leading modern engineers entertain of electric power transmission, and to put the result of my enquiry before you. Lest the general condition of the Niagara scheme may not be quite familiar to all of you, I shall now throw upon the screen a picture of the Falls, and give you very briefly an outline of the objects for which the Cataract Company has been established.

Of the immense power represented by the descent of the river from its upper to its lower level over the Falls (about 3½ million horse-power), there is utilised at present an aggregate of only about 5,000 h.p. in the mills you see on the left of the picture. The water is brought to these mills by a surface canal from the upper reaches of the river, and, after passing through turbines, is discharged into the open air about half-way between the level of the ground and the level of the river below the tail races, forming a number of miniature waterfalls. Only about half the available head is therefore utilised. If the system adopted hitherto could be followed in future, there would be little difficulty in establishing a station for the generation of any amount of power in this locality, but there is a strong tide of public opinion against the establishment of any more hydraulic works on the river bank, to say nothing of the difficulty of finding room for them and the open-air canal which would be required. The Cataract Company have therefore resolved to carry out their operations, to a great extent, underground; and at the present moment are driving a tunnel 30ft. high by 20ft. wide, and about 6,700ft. long, which is to serve as a tail race for the water coming away from their power station. This tunnel is shown on the picture by two dotted lines, and its mouth is partly submerged under the level of the lower river. The total fall between the upper and lower river is 200ft., and the net fall available for the turbines is 140ft. The fact that the tail race is a tunnel, necessitates the turbines being placed at least 110ft. underground, since the suction tube of a turbine cannot be made longer than the column of water which can be balanced by atmospheric pressure, and this increases very materially the engineering difficulties of the work.

Last summer the Cataract Company invited a limited number of engineers to send in projects for the creation and transmission of power, and instituted a commission, under the presidency of Sir William Thomson, to investigate and report on the projects. There were in all 20 competitors, but of these only 14 complied with the programme drawn up by the commission, and were therefore held to be qualified to have their projects examined. Of these 14, eight competitors sent in combined projects for the creation and transmission of power, four referred only to the creation, and two only to the transmission of the power. The point of interest to us is what methods were suggested by the 10 qualified competitors in transmission. The question is somewhat complicated by the fact that some competitors have suggested mixed systems of transmission, and that in classifying the schemes into electrical, pneumatic, and hydraulic, we must count some competitors twice over. On this basis I find that the following represents the transmission projects: Electrical seven, pneumatic six, hydraulic two. It is certainly remarkable that the balance in favour of electric transmission should be so small. And it is equally remarkable that there should have been as many as six competitors who either wholly or partly advocated pneumatic transmission. The experience of colliery managers goes to show that even over the comparatively short distances over which they use pneumatic transmission, the total efficiency lies generally between 20 and 30 per cent., and does certainly not exceed 40 per cent. We cannot suppose that engineers who have sent in pneumatic projects are ignorant of this fact, or at any rate we must suppose that the majority of them are quite aware that high efficiency cannot be expected from compressed air transmission. If, nevertheless, they have adopted compressed air in preference to electricity, it must be for one of two reasons. Either they have no confidence in the capabilities of electric transmission, or they consider the cost so high that the interest on the extra capital and the greater depreciation of the plant will more than counterbalance the advantage of high efficiency. It cannot be denied that in the present state of our knowledge of electric transmission, there is some ground for both these views. The Niagara problem is unique both in magnitude and distance, and I am bound to confess that we electrical engineers are at the present moment not quite prepared to face it. At the same time I must say that I feel convinced that in a few years from now there will be not one, but a dozen men ready to face this problem with a very good chance of successfully solving it. As a matter of fact, we are at present on the threshold of a new system of electric power transmission. The old system of using continuous currents and ordinary dynamos has been perfected to a point which leaves little to be desired, but it has its limits, and, unfortunately, the Niagara problem, or at least a part of it, is just a little beyond these limits. Hence we find that only about half of the competitors have had the courage to propose electric transmission. Of these, only two suggested the use of alternating currents at voltages of 5,000 and 10,000 respectively; the others followed the old lines of continuous-current transmission at voltages varying between 1,600 and 4,500 volts.

This brings me to the consideration of a subject which is of great importance not only in regard to the Niagara problem, but to long-distance transmission generally—namely, the limits of distance up to which the usual system of transmission is practicable. If you will refer to the table giving the cost of transmission plants, given in my last lecture, you will find that, for large powers at any rate, an increase of distance up to four or five miles does not make the cost prohibitive, and you will conclude from these figures that, within a five-mile limit, the old system of electric transmission is certainly feasible. How much farther you might go is a matter for theoretical consideration; the table does not help you much, as the only example of a very long-distance transmission is one where the power is small, and is therefore, in a certain sense, misleading. I have given you a formula by which you can calculate the most economical voltage for any distance; and if you do this for many cases, taking, for instance, 500 h.p. as your unit of power, you will find that as the distance increases beyond about five miles, the economical voltage begins to grow beyond the limit which might be considered practicable for one machine. It is quite impossible to lay down hard and fast rules. Under certain conditions, especially if you have to transmit cheap water power, you may possibly reach a distance of 10 miles before getting to the limit of voltage; but whatever may be the special conditions of the problem, there is a limit of distance beyond which a single machine will not reach. "Very well, then," you might say, "if a single machine cannot be made to give the required pressure, let us put two or three machines in series." To correctly appreciate such a suggestion, let us first of all see what limits the voltage of a machine. Two things limit it, the commutator and the general insulation. Practical dynamo makers will tell you that in large machines they are quite prepared to put 1,000 volts on the usual Pacinotti commutator—if necessary, they will go to 2,000 volts, but with some misgiving; and if you ask them to make a machine for 3,000 volts, they will, as likely as not, refuse. I do not refer to the Thomson-Houston or Brush machines, which have special commutators, but to large machines giving an even current and a high efficiency, such as we require in the transmission of power. We may thus conclude that 2,000, or, at the outside, 3,000 volts, is the limit of voltage to be obtained from a single commutator. But the general insulation of the machine must also stand this pressure, and where, as in dynamos and motors, the insulation consists of cotton, paper, fibre, varnish, and like materials, which are subjected not only to electrical, but also to mechanical strains, 3,000 volts is quite high enough for safe working. The commutator difficulty can of course be got over by putting several machines in series and insulating their frames from earth. The difficulty of general insulation can, however, not be met so easily. This you will see by referring to Fig. 7, which shows diagrammatically three 2,000-volt machines placed in series. Shunt excitation at the high pressure of 2,000 volts is, of course, out of the question; series excitation introduces complication and certain difficulties, especially at the motor station; and separate excitation, although simple and easily worked, has the disadvantage of throwing great electrical strains upon the insulation between the exciting coils and the frames of the machines. Imagine, for instance, that there is a weak place at A, between the exciting coil and the frame of the first machine, then the strain between the exciting coil and the frame of the third machine at B will be about 6,000 volts, even if all the machines are perfectly insulated from earth. With series self-exciting machines, the strain would of course be limited to 2,000 volts, but there still remains the difficulty that all the armatures would have to be mechanically connected by insulated couplings, and there would also be great danger in touching even the iron frame of any machine. You see the use of several machines in series is not such an easy matter as it may look at the first glance, and this method has, as far as I know, only been adopted in cases where the total voltage was under 2,000.

The net result of our investigation may be stated by saying that the electric transmission of power by continuous currents is economical and safe up to distances for which the most economical voltage does not exceed 2,000, or, at the outside, 3,000 volts, but that beyond these distances some other system must be applied. That this other system must also be electrical is evident, for we know perfectly well that distances beyond the reach of our present electric transmission systems are hopelessly beyond the reach of lines of shafting, flying ropes, air, or water. Now, what is this new electrical system which shall enable us to carry power over 10 or 20, or perhaps 100 miles.

In attempting to answer this question I must perforce leave the safeground of solid facts and engineering practice, and enter into the domain of speculation. Yet speculation based upon experimental results which, in themselves, are as reliable as were those experimental results which have led to the practical development of electric power transmission as we know it now.

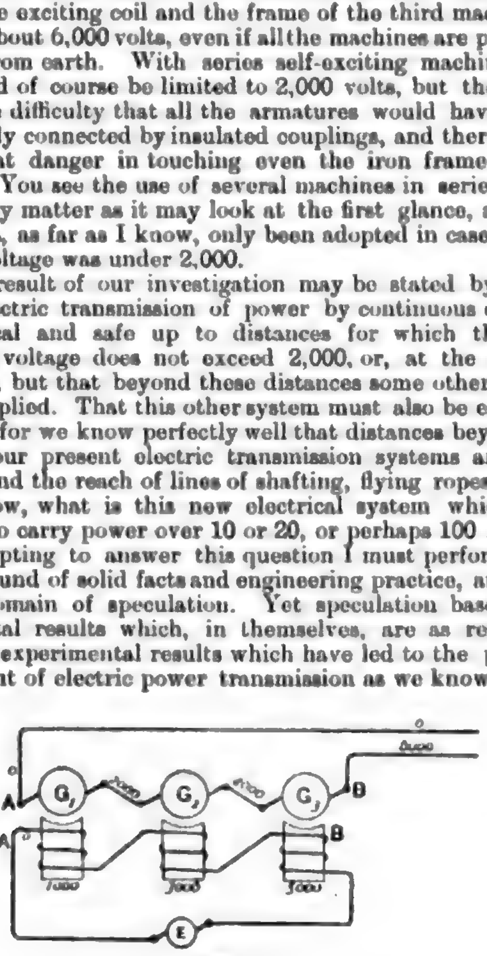

Fig. 7.

The starting point in the theory which I have now to bring before you is the well-known disc of Arago. If a copper disc be rapidly revolved under a compass needle, the latter is also set into rotation. I am able to show you this experiment, by the kindness of the Science and Art Department, who have lent me the apparatus you see before you. Between the copper disc and the compass needle is placed a sheet of glass so as to prevent air currents from affecting the needle. If I set the disc in motion you see that the magnet very soon follows. To make the motion of the latter better visible, coloured pieces of paper are attached to the poles. Now the fact that the magnet revolves is evidently due to there acting upon it some mechanical force. The explanation is perfectly simple. The disc, in passing under the poles of the magnet, becomes the seat of a very complex system of E.M.F.'s, which produce an equally complex system of currents. Some of these currents cross the path of the lines of force emanating from the magnet, and thus mechanical forces are set up between the disc and the magnet, causing the latter to rotate. It is as though there existed between the disc and the magnet a kind of electromagnetic friction by which the magnet is dragged after the disc. Since all motion is relative, it is perfectly clear that we might regard the magnet as revolving, and then the disc will be dragged after it. With the apparatus before you this experiment would not succeed, since the magnet is small and the disc is heavy; but if we were to employ a very strong magnet, and revolve it rapidly enough, there would be no difficulty in setting the disc in rotation, and even obtaining power from it. I have said a moment ago that the system of currents set up in the disc is very complex, and you will easily see that only those currents which are more or less radial, and of these only their radial components, are instrumental in exerting mechanical force, whilst all the other currents represent simply so much waste power. To make an efficient machine we must, therefore, not employ a continuous disc, but a system of conductors, so arranged as to force the currents to flow as much as possible in a radial sense, and only in those places which are immediately under the influence of the magnetic field. Or, better still, we may abandon the disc shape of conductors altogether, and substitute an armature with a laminated iron core of the drum type, seen end on in Fig. 8, and use, instead of a straight magnet, a horseshoe magnet, so shaped as to bring its poles, N S, to opposite sides of the drum, and wind the latter with a number of coils closed in themselves. If we now revolve the magnet, strong currents will be generated in each coil successively, and a very strong torque will be exerted on the armature. The torque will, in fact, be comparable to that required to revolve an ordinary continuous-current drum armature in a strong field if we short-circuit the brushes. Here, you see, we have, by applying a few very obvious improvements to the Arago disc, at once obtained a machine of very considerable power.

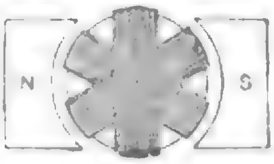

Fig. 8.

Imagine both the magnet and the armature mounted on independent spindles (not shown in the diagram, but passing both at right angles through the centre of the figure), then it is perfectly clear that power given to the magnet spindle is transmitted by electromagnetic induction to the armature, and a large portion of it may therefore be obtained again from the armature spindle. Here we have, certainly, transmission of power, but not of the kind we require, since the distance of transmission is nothing. Now, what we want to do is to so alter our machine so as to separate the two parts. We want the magnet in one place and the armature in another, miles away. If, in this case, we succeed in transmitting rotation from the magnet to the armature, then we shall have solved the problem. This problem has been solved by an Italian electrician, Prof. Galileo Ferraris, of Turin, who, early in 1888, communicated to the Turin Academy the results of his investigation on rotating magnetic fields produced by alternating currents. To clearly see the bearing which Ferraris's investigation has on our problem, let us enquire what it is we want at the motor station. We want there an armature, as shown in Fig. 8, and a magnetic field, the lines of which shall pass through the armature, and shall revolve round its centre. Whether the field is due to a real magnet, or is produced by any other means, is immaterial; and it is the merit of Ferraris to have shown us how to produce such a revolving field without the use of a real magnet, but simply by the use of two distinct alternating currents passing through fixed coils.

As the subject is new, and will not be found in any of the numerous text-books dealing with electrical engineering, you will perhaps not think it out of place if I put it before you in rather an elementary manner, beginning with the simplest possible case, and passing gradually to the more complicated cases. Assume, then, a combination of apparatus, as shown in Fig. 9. Here you have on the left an annular iron core wound with two coils, which are connected in series, and to a pair of line wires going to a similar coil on the right, which may be at any distance. Into the circular space enclosed by the first coil we put a straight bar magnet, N S, which can revolve round the centre. As the poles sweep past the wire turns and E.M.F. is induced, and a current is caused to flow, the direction of which changes twice in every revolution. We have here, in fact, an ordinary alternate-current generator with stationary armature and revolving field magnet. By suitably proportioning and placing the various parts of the apparatus, we can make the E.M.F. and the current curve of a true sine character; and, in order to simplify the treatment, I shall assume that in this, and in the cases which follow, the design is such that all the E.M.F. and current waves follow the sine law. The alternating current, in passing through the coils on the right, magnetise the iron core, so as to develop north and south polarity in the line M_1, M_1. The effect is the same as if we placed into the ring a vertical magnet which is collapsible, the two poles shrinking into a point at the moment that the current strength is zero, and coming apart vertically as the current increases.

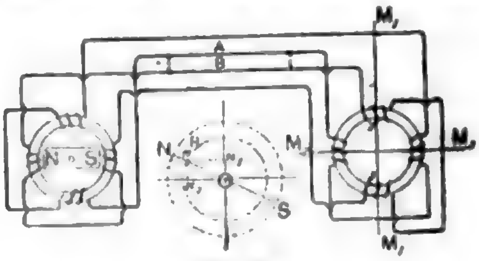

Fig. 9.

(*To be continued.*)

OSBO-PREMIER PRIMARY BATTERY.

A battery has been designed under the above name for supplying ght to small installations up to 30 lamps or so. The cell is of he single-fluid type, of carbon and zinc, and contains, in addition, reoxidising apparatus for reoxidising the depolariser, which ecomes reduced in the course of working by the nascent ydrogen. Besides the outer vessel and the elements, the cell ontains a porous tube with perforated bottom. This tube is ightly packed with the depolariser, and only requires renewal very six to nine months. In the upper part of the porous pot s a glass tube (with side tube and glass stopper), the side tube oing down into the depolariser itself. When it is to be used, a eoxidising bag is put in the tube with the addition of a little water, and the tube closed. A chemical action is thereby set up, which results in the liberation of oxygen, which flows through the ube into the depolariser, hence reoxidising that which has been educed.

The reoxidising bag consists of a special mixture of chloride of ime with a few crystals of nitrate of nickel; this, when cted upon by water or moisture, disengages oxygen, more specially if warmed. The battery solution provides for this, as n consequence of the chemical action it is always slightly above he temperature of the surrounding air. There is no action on pen circuit with this solution, as the zincs are heavily malgamated; nor is there smell or fumes. If it were not for the formation of zinc salts in the working of the cell, the same solution might be used indefinitely. The battery solution has to be changed, not because the depolariser s exhausted, but because the solution becomes finally clogged with the zinc salts. Theoretically, the battery may be said to run by consumption of zinc and chloride of lime. The 12-cell battery s stated to run 30 hours, yielding a constant output of 14 amperes t 24 volts, and using 30lb. of zinc at 2¼d., 2¼lb. of depolariser at d., and two dozen reoxidising bags at 2½d. per dozen. The cost s thus given as $14 \times 24 \times 30 = 10{,}080$ watts, or 10 B.T.U. for a cost of 7s. The labour of changing is small. The battery seems an nteresting departure, and we are informed that an installation will shortly be exhibited in London showing the battery in operation.

LEGAL INTELLIGENCE.

ROMPTON AND CO., LIMITED, v. PHILLIPS.—PHILLIPS v. CROMPTON AND CO.

The Lighting of Chelmsford.

The Court of Appeal (Lords Justices Lindley, Bowen, and Kay) delivered judgment on Wednesday in this case. It was an appeal by way of motion for a new trial from the decision of Mr. Justice Day and a special jury in an action brought in the Queen's Bench Division by Messrs. Crompton and Co. to recover damages for loss sustained by reason of defective wire supplied to them by Messrs. Phillips Bros. for the lighting of the town of Chelmsford, the verdict being given for the plaintiffs.

Mr. Finlay, Q.C., and Mr. R. W. Wallace were for the appellants, and Mr. Moulton, Q.C., and Mr. J. C. Graham for the respondents.

Lord Justice Lindley said the matter was of nterest, not only to the parties, but to persons interested in electric lighting. The plaintiffs were contracting to light Chelmsford, and applied to the defendants, who were well-known manufacturers, for wire. A etter was therefore written by the plaintiffs to the defendants saying they would require 4,000 yards of wire, and the letter said, "Please quote for B and C qualities; your terms must be special." The defendants replied, "We have much pleasure in quoting special prices for B and C qualities." Then an order was given for 4,000 yards of "C quality, to be at least ·012 thickness of rubber when vulcanised." The defendants supplied a large quantity of the wire, which the plaintiffs put up in the open air and unprotected. The wire proved unsatisfactory, and they had to take it down. The plaintiffs paid for the wire, and brought an action against the defendants to recover damages. Mr. Justice Day from the beginning to the end had directed the jury that the only question they had to consider was whether the defendants had supplied the plaintiffs with C quality wire—merchantable C quality wire. He told them distinctly that there was no guarantee n the letters, but it must be merchantable C quality wire. In order to ascertain what this was it was necessary to look outside the documents, and it was admitted that C quality wire was not a kind of wire generally known in the trade, but a quality of wire made and sold by the defendants. It was a term used by them to denote a particular article. Looking outside the letters, they were brought to the question—to his mind a cardinal question—and the only question they were discussing, did C quality mean covered wire or insulated wire? If it meant covered wire the defendants' had performed their contract, and if insulated was meant, they had not performed their contract. Evidence of this kind was to be obtained partly from what occurred, partly from the defendants' evidence, partly from a telegram which referred to the question of nsulation, and partly from a letter from the defendants, and putting hese together, it appeared to him impossible to say that there was no evidence which warranted the jury in finding that C quality meant wire, and not covered wire. If they once got to the starting point that the order was for insulated wire, the evidence was overwhelming that this was not insulated wire, and it was impossible to disturb the verdict. It had been argued with very great force by Mr. Finlay and Mr. Wallace that the failure which had arisen was attributable entirely to the fact that the plaintiffs applied the wire to a purpose for which it was utterly unsuited. That was perfectly true, but how it came to be so applied? The answer was that the plaintiffs assumed, and had a right to assume, that it was merchantable C quality wire—in other words, insulated, as distinguished from simply covered wire. It was no answer to say that this covered wire was amply sufficient for all indoor purposes. Uncovered wire, with proper protection where it came into contact with conducting surfaces, would be sufficient for indoor purposes, but the moment the jury found themselves entitled to treat the wire as insulated, the case for the defendants failed. The verdict was a curious one. Mr. Justice Day had placed great stress from first to last upon the point that the only matter the jury had to consider was whether the wire supplied was C quality, and the reason he did that was that attempts were made to bring in other topics—for example, that the wire ought not to have been applied to outdoor purposes. Mr. Justice Day had set himself resolutely against that. The verdict was, "We find for the plaintiffs, but we feel that Messrs. Crompton have been guilty of contributory negligence in not examining the goods, which were an exceptionally bad article." It was said by Mr. Finlay and Mr. Wallace that exceptionally bad meant exceptionally bad for the purpose to which it was applied; that it ought never to have been applied to an outdoor line, for thenit was exceptionally bad. But the defendants said they had never meant it for that purpose. He (Lord Justice Lindley) thought, however, that it was susceptible of the meaning that it was an insulated wire, and that it was an exceptionally bad article of the kind as an insulated wire. What the jury meant by the expression "contributory negligence," was an intimation that when the jury came to consider the question of damages they were not going to give the plaintiffs the cost of putting up and taking down the wire, because they ought to have examined it. As it appeared, the question of damages never went to the jury, because the damages were referred, and he supposed the gentleman who had to deal with the question would take the same view. It appeared to him (Lord Justice Lindley) that it would be utterly unreasonable and wrong to give the plaintiffs all the cost of putting up and taking down the wire, because they could have discovered without the slightest trouble that the wire was unfit for the purpose. It was impossible to say that the verdict was against the weight of evidence, or that there had been such a miscarriage of justice as would warrant a new trial. He attributed the unfortunate misunderstanding which had arisen entirely to the ambiguity of the words used. If the defendants had sold this as covered wire, there would have been no difficulty.

Lord Justice Bowen said he entirely agreed.

Lord Justice Kay said he also entirely agreed. It appeared that the defendants made several qualities of wire, and on their cards they used the words "Electric Light Leads" and "Manufacturers of Telegraph Wires of any Specification." There could be no doubt, looking at the card, that their wires were meant for electric lighting. On the card, C quality was described as "vulcanised indiarubber insulation"; D, of a higher quality, was described as "vulcanised indiarubber higher insulation." Therefore, the card represented C as a wire insulated, it being covered with vulcanized indiarubber. It was plain that the person who wrote the first time did so with the defendants' card before him, and that he was ordering insulated wire. Of that there could be no kind of doubt. Then if he ordered insulated wire, the defendants sold this C wire as they described as insulated wire. During the progress of fixing the wire at Chelmsford the plaintiffs were anxious to know what was the resistance of this insulation, and they got an answer from the defendants that the approximate resistance of No. 14, C quality, was 250 ohms per unit; 250 ohms per unit they were told would carry an enormous current of electricity, and be a very perfect insulation indeed. Counsel in the Court below had admitted that the proper mode of testing the wire was by placing it in water and passing a current through it, and he (Lord Justice Kay) found in the shorthand notes that one of the plaintiffs' witnesses, Mr. Kemp, had said this was the proper method of testing, and counsel for the defendants had concurred. And evidence was given by Prof. Jamieson, which was quite uncontradicted, with reference to a report which was made by someone else, and had been approved by him, to the effect that the report contained a statement that the installation of the wire was so bad that the electricity ran through it so quickly that it would give no practical insulation whatever; and in answer to Mr. Justice Day, Prof. Jamieson had said that the insulation was so leaky the current was all drawn away, and at the further end they could not get a current at all. So that in some specimens of the wire the whole of the current escaped, from the imperfections of the insulating covering. If that wire was sold as insulated wire, and bought as insulated wire, the question was, Was it in fact insulated wire? The test of insulation showed that some parts of the wire were so bad that no current would go through, and other parts were proved to be exceedingly defective. Upon this evidence the jury might well find that, whatever C quality meant, it meant at least that the wire was insulated, and this wire was either not insulated at all or it was insulated so imperfectly as not to deserve to be called insulated wire. He did not say whether they were right or wrong, but there was ample evidence to go to the jury to justify their finding that this wire was not the wire which the plaintiffs contracted to buy; that being so, it seemed to him quite impossible that the Court could in any way disturb the verdict.

Motion refused accordingly.

NEW COMPANIES REGISTERED.

Electrical Assets Purchase Company, Limited.—Registered by Robinson and Stannard, 19, Eastcheap, E.C., with a capital of £1,000 in £1 shares. Object: to acquire the undertaking of the Liepmann Carbon Company, Limited, including certain patents relating to improvements in the manufacture of carbon for electric lighting, and to work the same, in accordance with an agreement, made July 13, between the Liepman Carbon Company, Limited, of the one part, and C. E. H. Hoskins of the other part. With slight modifications, the regulations contained in Table A apply.

Epstein Electric Accumulator Company, Limited.—Registered by A. L. Foley, 2, Maisemore-mansions, South Hampstead, with a capital of £101,000 in £1 shares. Object: To acquire certain patents and patent rights relating to improvements in the manufacture and use of secondary or storage batteries, and to carry on the business of an electric light and power company in all its branches, on the Continent of Europe or elsewhere. The first subscribers are:

	Shares.
Sir J. D. Mackenzie, Bart., Worcester Park, Surrey	1
H. G. Rawson, 6, Pump-court, Temple	1
L. Epstein, 5, Cambridge-villas, East Twickenham	1
J. Maier, Ph.D., 23, Melrose-gardens, W.	1
G. T. Broadbridge, 55, Doddington grove, Kennington Park, S.E.	1
F. Harland, 69, Lavender-sweep, Clapham Common	1
J. Davies, 46, Derby-road, Croydon	1

There shall not be less than three nor more than 12 Directors; the first shall be elected by the subscribers to the memorandum of association. Qualification, holding shares. Remuneration to be determined in general meeting.

Morecambe Electric Light and Power Company, Limited.—Registered by T. R. Hargreaves, 9, Bridge-street, Westminster, with a capital of £15,000 in £1 shares. Object: to acquire the undertaking of the Morecambe Electric Light and Power Company now carried on by T. R. Andrews and T. Preece, in accordance with an agreement made June 27 between the said T. R. Andrews and T. Preece of the one part, and J. Jowett on behalf of the Company of the other part, and to carry on in all its branches the business of electricians, electrical and mechanical engineers, etc. Registered without articles of association.

COMPANIES' MEETINGS.

ANGLO-AMERICAN TELEGRAPH COMPANY, LIMITED.

The half-yearly general meeting of this Company was held on Friday last at Winchester House, the Marquis of Tweeddale presiding.

The **Chairman**, in moving the adoption of the report, stated that the dividend of 12½ per cent. on the ordinary stock was a little disappointing to the Directors, but he did not think that anyone who was acquainted with the state of affairs, more especially in the commercial world, during the period under review, would be surprised at this result. Owing to the interruption on the west coast of South America their traffic had been reduced by £10,000. He was glad to say that the interruption which had so long existed was now removed, and that their traffic in that quarter was resuming its normal condition. He was quite satisfied that they had not suffered in any degree more than their competitors in the Atlantic. They had provided a through wire from Paris to Brest and Havre, and had thus placed themselves on an equality with their competitors in that country. At their last meeting one of their largest shareholders and customers complained that the Company's lines were subject to interruptions in the winter which greatly interfered with his business. He was glad to say with respect to this matter that the Western Union Company had shown themselves alive to the necessity and importance of placing the communications under their control in a far more satisfactory condition. The able general manager of that company had written them a letter in which he stated that, even with a repetition of the unparalleled weather of last winter, the precautions they had taken would prevent any unappreciable delay in the business on this company's side. The Directors had also determined to take steps to connect Sydney and Canso by cable, and in this way they would have direct communication by submarine cable between England and France and New York, which they had never hitherto had. The short line known as the North Placentia cable had given them a gread deal of trouble, and would require some additional cable in order to make it as efficient as it should be. The renewal fund had reached the handsome sum of £990,000, and at current prices was worth about £29,000 more. It might interest them to know that during the last 4½ years they had charged the renewal fund with repairs and renewals, costing about £120,000, being at the rate of about £27,000 a year, while the income from the renewal fund was about £32,000. He then referred to the suit between the Company and the Paris and New York Telegraph Company, and said that on the 1st of May the Council of State set aside the order of the Court of Prefecture of the Seine, and determined that the letter of M. Granet of the 30th of December, 1886, had not the effect of an order compelling the French company to break the contracts, but that it only amounted to an invitation to the French company to take immediate steps to put itself right according to the conditions of its concession. Since the date of that judgment there had been a correspondence between the French company and its Government, from which it appeared that the present Government would not sanction the joint-purse agreements. The case would now go back to the Court of Appeal, which would decide—and, he hoped, finally—the amount of damages to which this Company was entitled through the unjustifiable conduct of the French company. There was no doubt that a gross breach of agreement was committed; but whether the French Court would see fit to give the Anglo-American Company considerable damages on this account or not, he would not venture to predict.

Mr. Francis A. Bevan (the deputy chairman) having seconded the motion,

Mr. Thomas Smith (York) proposed an amendment in favour of the payment of a higher dividend and rejecting the report. He contended that the expenses incurred by the opening of new offices ought to have been charged to capital and not to revenue, and that, if necessary, the dividend should be supplemented out of the renewal fund.

Mr. Brandon seconded the amendment, and complained that the deferred stockholders had received no dividend for seven years.

Mr. Wreford and **Mr. Jackson** endorsed the views of Mr. Smith.

The **Chairman**, in reply, said that the amendment was out of order. He maintained that the cost of the new offices could not have been debited to the renewal fund, and that rent could only be charged to maintenance. They could only pay a dividend out of net receipts; and he repeated what he stated at the last meeting with regard to the renewal fund—that it had always been recognised that £1,000,000 was the very least that they should have at their credit, having regard to the age and condition of their cables, and the necessity some day of renewing them. It would be idle to suppose that at the present time they could realise, at the existing middle quotations, the investments forming the renewal fund.

The resolution was eventually carried by 13 to six.

COMPANIES' REPORTS.

BIRMINGHAM CENTRAL TRAMWAYS COMPANY, LIMITED.

Directors: Joseph Ebbsmith, Esq. (chairman), M. J. Smith, Esq., William Neale, Esq., W. J. Carruthers-Wain, Esq., A.M.I.C.E (managing director).

Report of the Directors, to be submitted to the shareholders at the tenth ordinary general meeting, to be held at the Queen's Hotel, Stephenson-place, Birmingham, on Tuesday, the 11th inst., at 12.30 p.m.:

The traffic of the Company continues to show a satisfactory increase, but the working expenses of the year have been excessive. The unsettled conditions of the fuel market has severely affected profits, especially those of the steam lines. Corporation charges for maintenance of the permanent way have far exceeded the estimates based upon previous experience. The rearrangement of working hours and wages has secured the goodwill and contentment of the servants of the Company, but has materially increased working expenses. Taken as a whole, however, the shareholders may view the year's working with satisfaction. The cable lines have more than maintained their earning capacity, and the electric lines, which in the first half of the year were suffering from exceptional difficulties of construction and maintenance, have apparently overcome those difficulties, and show a substantial profit, which is steadily improving. The comparative statement of traffic and profit is subjoined (Table A). The revenue account shows a balance of £25,657. 16s. 9d., to which has to be added the sum of £6,124. 7s., brought forward from last year's accounts, making together £31,782. 3s. 9d. Your Directors recommend: 1. That the sum of £10,000 be placed to reserve account against depreciation. 2. That the payment of the dividend upon

TABLE A.—COMPARATIVE STATEMENT OF ACCOUNTS.

Year ending	Miles run.	Passengers carried.	Traffic receipts, etc.			Working expenses.			Working profits.		
			£	s.	d.	£	s.	d.	£	s.	d.
June 30th, 1888	1,913,936	15,821,441	100,664	15	3	70,354	18	0	30,309	17	3
June 30th, 1889	2,073,505	18,372,409	115,426	10	9	77,947	11	2	37,478	19	7
June 30th, 1890	2,426,280	22,182,041	133,215	9	6	88,339	7	0	44,876	2	6
June 30th, 1891	2,483,397	24,831,323	143,307	17	1	99,728	4	7	43,579	12	6

BIRMINGHAM TRAMWAYS.—WORKING ACCOUNTS FOR THE TWELVE MONTHS ENDING JUNE 30, 1891.

Steam Department.

Dr.

Average ·mile run. 1.	d.		£	s.	d.	£	s.	d.
		Engines:						
06		Wages	10,191	9	3			
90		Fuel	9,357	6	1			
·22		Water and gas	1,069	2	9			
35		Stores	1,720	13	8			
07		Sundries	339	16	10			
89		Repairs—Wages	4,394	9	7			
·89		" Materials	4,391	3	1			
	6·38					31,464	1	3
		Car repairs:						
·18		Wages	879	7	2			
·15		Materials	731	19	2			
	·33					1,611	6	4
		Traffic expenses:						
·35		Wages	6,666	16	11			
·11		Water and gas	561	15	0			
·06		Stores	282	13	0			
·13		Stationery, tickets, and punch royalty	657	9	9			
·03		Sundries	124	16	1			
	1·68					8,293	10	9
		Permanent way and buildings:						
·27		Wages	1,303	17	11			
·28		Materials	6,336	7	6			
	1·55					7,640	5	5
		General charges:						
·08		Stationery and incidentals	375	1	9			
·10		Salaries	491	18	10			
·16		Compensation	799	12	5			
·36		Rates, taxes, and insurances	1,782	7	0			
·30		Professional charges	1,499	14	7			
·05		Sundries	261	2	10			
	1·05					5,209	17	5
	10·99					54,219	1	2
	4·68	Balance to revenue account				23,118	15	8
	15·67					£77,337	16	10

Cr.

Average per mile run. d.	d.		£	s.	d.
15·49		Traffic receipts	76,454	6	4
		Advertisements	883	10	6
·18					
	15·67		£77,337	16	10

Note.

Miles run 1,184,401

Passengers carried 14,242,827

Horse Department.

Dr.

·verage per mile run. d.	d.		£	s.	d.	£	s.	d.
		Horses:						
2·44		Wages	6,478	18	8			
3·72		Forage and bedding	9,872	18	9			
·40		Veterinary and shoeing	1,052	9	8			
·06		Water and gas	166	5	6			
·16		Harness repairs	424	6	0			
·04		Stable utensils	116	9	6			
·08		Sundries	199	6	10			
·43		Renewals	1,150	19	0			
	7·33					19,461	13	11
		Vehicle repairs:						
·28		Wages	752	4	5			
·26		Materials	674	4	2			
	·54					1,426	8	7
		Traffic expenses:						
1·05		Wages	2,799	10	4			
·04		Water and gas	91	6	6			
·03		Stores	89	0	4			
·10		Stationery, tickets, and punch royalty	266	9	10			
·04		Sundries	114	0	3			
	1·26					3,360	7	3
		Permanent way and buildings:						
·02		Wages	43	16	6			
·12		Materials	318	12	10			
	·14					362	9	4
		General charges:						
·06		Stationery and incidentals	157	10	6			
·09		Salaries	258	1	7			
·03		Compensation	75	3	10			
·20		Rates, taxes, and insurances	527	1	8			
·08		Professional charges	208	15	1			
·06		Sundries	165	0	1			
	·52					1,391	12	9
	9·79					26,002	11	10
	1·23	Balance to revenue account				3,274	3	4
	11·02					£29,276	15	2

Cr.

Average per mile run. d.	d.		£	s.	d.	£	s.	d.
		Traffic receipts:						
		Tramways	5,048	12	10			
9·21		Omnibuses, etc.	23,507	8	6			
11·15						28,556	1	4
		Advertisements				371	12	6
	10·75	Manure				349	1	4
	·14							
	·13							
	11·02					£29,276	15	2

Note.

Miles run { Tramways ... 131,528
Omnibuses ... 506,196

Passengers carried { Tramways ...1,114,398
Omnibuses ...2,638,028

e 5 per cent. guaranteed shares, amounting to £5,000, be confirmed. . That a dividend of 4 per cent. for the year ending June 30, 891, be declared and paid upon the ordinary shares of the ompany, amounting to £15,520, and that the same be payable on ugust 31, 1891. 4. That the balance of revenue account, amounting to £1,262. 3s. 9d., be carried forward. With the completion of the Bristol-road line the Company will have concluded the extensions to which the shareholders were committed when the present Board were appointed to office. No further capital expenditure is contemplated. Mr. Joseph Ebbsmith and Mr. M. J.

BIRMINGHAM TRAMWAYS.—WORKING ACCOUNTS FOR THE TWELVE MONTHS ENDING JUNE 30, 1891.

CABLE DEPARTMENT.

Dr.

Average per mile run. d.	Average per mile run. d.		£	s.	d.	£	s.	d.
		Cable haulage:						
1·46		Wages	3,180	16	8			
·66		Fuel	1,445	13	9			
·19		Stores	401	7	7			
·07		Water and gas	152	6	11			
·03		Sundries	61	16	9			
	2·41					5,242	1	8
		Cables and machinery:						
·07		Wages	169	13	1			
·88		Materials	1,918	5	8			
	·95					2,077	18	9
		Car repairs:						
·17		Wages	366	13	0			
·66		Materials	1,444	10	1			
	·83					1,811	3	1
		Traffic expenses:						
1·05		Wages	2,293	8	5			
·07		Water and gas	152	6	10			
·04		Stores	92	3	1			
·11		Stationery, tickets, and punch royalty	230	2	6			
·03		Sundries	52	12	5			
	1·30					2,820	13	3
		Permanent way and buildings:						
·01		Wages	21	15	1			
·12		Materials	256	17	5	278	12	6
	·13							
		General charges:						
·05		Stationery and incidentals	105	10	1			
·10		Salaries	214	19	11			
·08		Compensation	180	16	10			
·35		Rates, taxes, and insurances	778	15	9			
·06		Professional charges	140	5	1			
·07		Sundries	144	6	3			
	·71					1,564	13	11
	6·33					13,795	3	2
	6·50	Balance to revenue account				14,166	0	3
	12·83					£27,961	3	5

Cr.

Average per mile run. d.	Average per mile run. d.		£	s.	d.
12·75		Traffic receipts	27,781	2	10
·08		Advertisements	180	0	7
	12·83		£27,961	3	5

NOTE.

Miles run 522,876

Passengers carried 5,241,362

ELECTRIC DEPARTMENT.

Dr.

Average per mile run. d.	Average per mile run. d.		£	s.	d.	£	s.	d.
		Electric haulage:						
2·60		Wages	1,501	16	1			
1·66		Fuel	955	13	3			
·73		Stores	420	0	5			
·07		Water and lighting	39	5	7			
·09		Sundries	53	15	10			
	5·15					2,970	11	2
		Machinery:						
·00		Wages	1	2	0			
·29		Materials	167	1	5			
	·29					168	3	5
		Car repairs:						
·60		Wages	349	1	8			
1·33		Materials	763	15	11			
	1·93					1,112	17	7
		Traffic expenses:						
1·08		Wages	619	19	3			
·07		Water and lighting	39	5	9			
·02		Stores	14	12	1			
·13		Stationery, tickets, and punch royalty	74	5	9			
·04		Sundries	23	13	8			
	1·34					771	16	6
		Permanent way and buildings:						
·08		Wages	42	18	10			
·06		Materials	35	13	6			
	·14					78	12	4
		General charges:						
·07		Stationery and incidentals	40	9	11			
·10		Salaries	57	15	7			
·08		Compensation	44	2	6			
·51		Rates, taxes, and insurances	294	0	5			
·18		Professional charges	109	2	4			
·11		Sundries	63	16	8			
	1·05					609	7	5
	9·90					5,711	8	5
	5·25	Balance to revenue account				3,020	13	3
	15·15					£8,732	1	8

Cr.

Average per mile run. d.	Average per mile run. d.		£	s.	d.
1·502		Traffic receipts	8,656	10	11
0·13		Advertisements	75	10	9
	15·15		£8,732	1	8

NOTE.

Line opened ...24th July, 1890

Miles run 138,396

Passengers carried 1,144,718

Smith (two of the directors) retire, and, being eligible, offer themselves for re-election. Messrs. Howard Smith, Slocombe, and Co., and Mr. G. H. Sargant offer themselves for re-election to the joint auditorship of the Company.

BIRMINGHAM TRAMWAYS.

Balance-sheet, June 30, 1891.

Dr.				£	s.	d.	£	s.	d.
Capital authorised—									
400,000 ordinary shares at £10 each				400,000	0	0			
10,000 guaranteed shares at £10 each				100,000	0	0			
				500,000	0	0			
Capital subscribed—									
38,800 ordinary shares at £10 each				388,000	0	0			
10,000 guaranteed shares at £10 each				100,000	0	0			
				488,000	0	0			
Less calls in arrear				272	0	0			
							487,728	0	0
Debenture and special creditors							130,200	0	0
Sundry creditors							27,871	9	6
Reserve fund as per last account				33,952	10	0			
Premiums received	9	0	0						
Amount voted at last general meeting for reserve against depreciation	10,000	0	0						
				10,009	0	0			
				43,961	10	0			
Deduct discount on debentures				1,203	0	0			
							42,758	10	0
Unclaimed dividends							137	0	5
Debenture interest for half-year ending June 30, 1891							2,412	3	0
Advance by bankers (capital account)							49,742	0	2
Revenue account, as per last balance-sheet				6,124	7	0			
Revenue account for the year ending June 30, 1891				25,657	16	9			
				31,782	3	9			
Less interim dividend paid on 5 per cent. guaranteed shares to December 31, 1890				2,500	0	0			
							29,282	3	9
							£770,131	6	10

Cr.				£	s.	d.
Capital expenditure at June 30, 1890, as per balance-sheet at that date				597,560	6	8
Bristol-road electric line and depot				21,650	16	0
Other additions to date				16,809	10	4
				£636,020	13	0
Cash deposits—						
Corporation of Birmingham	68,580	2	3			
Board of Trade	716	10	0			
				69,296	12	3
Stock of stores				14,992	16	6
Sundry debtors and unexpired value of licenses and insurances				7,622	5	4
Cash at bankers (revenue account)				41,759	9	1
Cash in hand				439	10	8
				£770,131	6	10

Revenue Account, Twelve Months ending June 30, 1891.

Dr.	£	s.	d.	£	s.	d.
Directors' fees	750	0	0			
Directors' travelling expenses	58	1	4			
Managing Director's remuneration and percentage	1,336	10	6			
Salaries of secretary and his staff	517	13	2			
Auditors' fees	105	0	0			
				2,767	5	0
Rents	1,360	12	7			
Corporation of Birmingham, payments under lease	9,725	5	0			
Birmingham and Aston Tramways Company, Limited, running powers	1,471	8	4			
				12,557	5	11
Balance carried down				28,560	9	2
				£43,885	0	1
Interest on debentures and special loans				5,484	16	6
Contribution to employés' sick club				105	0	0
Balance				25,657	16	9
				£31,247	13	3

Cr.	£	s.	d.	£	s.	d.
Balance of steam department	23,118	15	8			
Balance of horse department	3,274	3	4			
Balance of cable department	14,166	0	3			
Balance of electric department	3,020	13	3			
				43,579	12	6
Rents	262	7	7			
Transfer fees	43	0	0			
				305	7	7
				£43,885	0	1
Balance brought down				£28,560	9	2
Interest on deposit	2,684	10	3			
Interest on calls	2	13	10			
				2,687	4	1
				£31,247	13	3

GERMAN CONTINENTAL GAS COMPANY.

The *Journal of Gas Lighting* gives an abstract of the report of this Company, from which the following extracts are taken:

"The Company have sought unremittingly to encourage the introduction of gas for heating and the production of motive power, not only by the manufacture of suitable appliances, but also by reducing the cost of installations to the consumers. The construction of large gas engines has commenced successfully. During the past year this work extended to the production of twin motors of 140 h.p., built in England on the 'Otto' system; whereas during the erection of the Company's electrical station at Dessau, in 1886, the largest gas engines known were twin motors of 60 h.p., and gas motors of 100 h.p., with four cylinders, were introduced for the first time in 1889. All experience and theoretical considerations up to the present justify the assumption that the sphere of usefulness of gas engines is by no means limited to small motors; but that, in fact, it will continually extend in the direction of power producers of great magnitude, inasmuch as, under such circumstances, there is simultaneously a substantial reduction in the consumption of gas per horse-power. This progress in the construction of gas engines is, moreover, of importance for the production of electric light in large centres; since even at the present time the Company are in a position, by means of a single 140-h.p. twin engine, in conjunction with adequate accumulators, to feed 4,000 incandescent lamps burning simultaneously, which corresponds to an installation of 5,000 lamps. Three such motors placed side by side, like steam engines are at the present time, could keep going an installation of 15,000 16-c.p. glow lamps, which would be sufficiently extensive for very many towns. But then all predictions indicate that the construction of gas engines will not remain long at 140 h.p.; and the combination of electrical concerns with the present gas institutions, besides showing a reduced cost of management, offers, when compared with a steam engine installation, the advantage that the supply station may be placed in the very centre of a town, in the heart of the electric light system, which, moreover, would diminish the cost of cable laying without fear of trouble from smoke or explosions, with smaller requirements as regards ground, and consequently lower rent. The competition of the electric light has, up to the present time, not impeded anywhere, within the range of the Company's activity, the natural increment in the output of gas; in fact, the latter, as formerly, is influenced primarily by the commercial position of industrial matters and general business activity. The statistics relating to the different stations of the Company show that all of them augmented their production of gas, as well as recording increments in the number of lights. The largest proportional increase was at the Hagen-Herdecke-Haspe station; the increase being 18·69 per cent. on the previous year's production, and 13·73 per cent. on the number of lights. The growth of the gas supply from this station has within the past three years made the Company attain a supply approximating to that which they had immediately before the opening of the competing municipal gas works in 1888. The reduction in the consumption of gas at the Hagen railway station since the 1st of January will, therefore, presumadly soon again be counterbalanced; and, in fact, the sale of gas at a better price will help this. But the success of the Company was considerably prejudiced by the assessment for the communal rates, about which contradictory decisions have been expressed by the higher administrative body, which will necessitate an appeal to the superior Courts. The lowest proportional advance is recorded from the Warsaw Praga station, with 2·19 per cent. increase of production, and only 0·57 per cent. lights above the number for 1889. This is wholly attributed to the bad state of commerce and industry. Intermediate betwen these come the stations at Frankfort-on-the-Oder, Potsdam-Neuendorf, Luckenwalde, Minchen-Gladbach-Rheydt-Odenkirchen, Nordhausen, Lemberg, Gotha, Herbesthal, and Ruhrort. At the last station, Herr F. Hannibal was appointed manager in place of Herr Wagner, who was transferred to the Dessau station, where the production was 10 per cent., and the number of lights 9·51 per cent., more than in the previous year; while the electrical department showed, in comparison with 1889, the following increments: Production in ampere-hours, 33·754, or 10 per cent.; number of arc lights, 5, or 9·26 per cent.; number of incandescent lamps, 141, or 4·61 per cent. The total illuminating power of these additions, reduced to 16 candles, was 124, or 3·46 per cent. The completion of the new battery of accumulators mentioned in last year's report has increased the supplying capacity as well as diminished the working expenses of this station, so that the average consumption of gas per horse-power was 0·750 cubic metre, as compared with 0·953 cubic metre in 1889. The average efficiency of these accumulators for the year amounted to 78·9 per cent.—highly satisfactory figures when one takes into consideration how very unfavourable the extremely small summer demand is for the utilisation of the accumulators. The financial results of this station—opened Sept. 13, 1886, and, next to that in Berlin, the oldest central station in Germany—were for the first time to a certain extent gratifying, for though the average age of the lamps for the year was only 180 instead of 500 hours, and their profitableness depends on their hour-burning capacity, there has been some recompense in improvements in the construction of motors, dynamos, etc., and in the general accessories of such an installation. At Erfurt, where the Company have another electrical station, the lighting of the town hall by electric light resulted last year in a loss of 3,090·72 marks, as compared with a deficit of 3,106·11 marks in the previous year. The Company's operations at their 13 gas-making stations, the central electric station, and the central factory at Dessau, resulted, as shown by the profit and loss account, in a profit of 2,556,582·42 marks, which is only 52,549·02 marks less than that of the very favourable working the previous year."

CITY NOTES.

West Coast of America Telegraph Company.—The receipts for the month of July were £2,075.

Cuba Submarine Telegraph Company.—The traffic receipts for July were £3,100, against £3,134.

Great Northern Telegraph Company.—The receipts of this Company for July amounted to £24,000.

Direct Spanish Company.—The traffic receipts of this Company for the month of July were £1,667, against £2,016.

Eastern Telegraph Company.—The receipts for the past month were £52,303, as against £54,224 for the same period of 1890, showing a decrease of £1,921.

Brazilian Submarine Telegraph Company.—The receipts of this Company for the week ended July 17 amounted to £3,632, and for the week ended July 24 to £5,152.

Eastern Extension Company.—For July the traffic receipts of this Company amounted to £41,219, as against £46,367 in the corresponding period, showing a decrease of £5,148.

West India and Panama Telegraph Company.—The receipts for the half-month ended July 31 were £2,058, against £2,702. The March receipts, estimated at £6,431, realised £6,391.

Western and Brazilian Telegraph Company.—The receipts for the weeks ended July 17 and 24, after deducting 17 per cent. payable to the London Platino-Brazilian Company, were £2,280 and £3,319 respectively.

City and South London Railway.—This Company's receipts for the past week amounted to £692. The accounts of the Company for the six months to June 30 show a balance of net revenue, including £525 brought forward, of £4,693. Of this amount, the interest on debentures absorbs £4,137, leaving a balance of £555 to be carried to the next account.

Companies of the Month.—The following electrical companies have been registered during the past month :

City of Waterford Electric Supply Company, Limited, £5 shares	£1,000
City of London Electric Lighting Company, Limited, £10 shares	800,000
East London Electric Supply Company, Limited, £5 shares	1,000
Electrical Assets Purchase Company, Limited, £1 shares.	1,000
Epstein Electric Accumulator Company, Limited, £1 shares	101,000
Home Telephonic Company, Limited, £5 shares	500
Italian Electrical Light and Power Company, Limited, £4 shares	60,000
Morecambe Electric Light and Power Company, Limited, £1 shares	15,000
St. John, Hampstead, Electric Supply Company, Limited, £5 shares	1,000
Taylor-Smith Electric Company, Limited, £10 shares	6,000
Wyndham Electric Light Company, Limited, £1 shares	1,500

PROVISIONAL PATENTS, 1891.

July 27.

12793. **Improvements in or connected with switchboards for electrical purposes.** Tom Hawkins, Norfolk House, Norfolk-street, Strand, London.

12720. **Improvements in electric coal-cutting and mineral-cutting machines.** Albion Thomas Snell, 52, Chancery-lane, London.

12726. **Improvements in the construction of armatures for certain kinds of electrical machines.** William Phillips Thompson, 6, Lord-street, Liverpool. (W. Lahmeyer and Co., Germany.)

12727. **Improvements in the method or means of regulating motor-dynamos or continuous-current transformers.** William Phillips Thompson, 6, Lord-street, Liverpool. (W. Lahmeyer and Co., Germany.)

12731. **An automatic locomotive or electrical engine.** Claude Salusbury Foljambe Mellor, 8, Lyric-chambers, Whitcomb-street, Haymarket, London.

July 28.

12774. **A new electro-diamagnetic self-rotating dynamo.** Otto Francis, 26, Budge-row, Cannon-street, London.

12792. **An improved bolt socket electric light switch.** Arthur William King, 65, Winchester-street, Pimlico, London.

12799. **Improvements in and relating to system of electric distribution.** Morris Fielbogen, 77, Chancery-lane, London. (Complete specification.)

12824. **An improvement connected with electric lighting apparatus.** Germinio Zanni, 166, Fleet-street, London.

12828. **Improvements relating to electric motors chiefly designed for railway and other vehicles, and to electric generators.** Henry Harris Lake, 45, Southampton-buildings, London. (The Thomson-Houston International Electric Company, United States.) (Complete specification.)

12831. **Improved curative electric belt.** William Russell, 1, Quality-court, London.

July 29.

12859. **A method of and means for combining at will telephonic communication with ordinary methods of electrical signalling in or about coal and other mines and works and other places.** George Wilson, Bristol Bank-buildings, Bristol.

12898. **Improvements in means to be employed in the electrical deposition of copper.** Thomas Parker, 47, Lincoln's-inn-fields, London.

July 30.

12904. **Improvements in holders for incandescent electric lamps.** Ronald A. Scott, 46, Lincoln's-inn-fields, London.

12934. **An electrical parcel exchange system.** Alfred Rosling Bennett, 22, St. Albans-road, Harlesden, London.

12946. **Improvements in the electro-deposition of platinum.** Illius Augustus Timmis and William Henry Walenn, 2, Great George-street, Westminster, London.

12960. **Improvements in electric transformers.** William Morris Mordey, 46, Lincoln's-inn-fields, London. (Complete specification.)

July 31.

12982. **An electric automatic time check.** Frederick George Manley Wetherfield, 1, Gresham-buildings, London. (Charles Kennedy Jardine, Demerara.)

12985. **Improvements in means or apparatus for use in automatic electric railway signalling.** Reginald Bradalbin Annesley, John Harvey Evans, and Edwin Blakey, 78, Fleet-street, London.

13015. **Improved electric insulator.** George Harley Graham and Thomas Gannane, 106, Victoria-chambers, Chancery-lane, London.

August 1.

13087. **Improvements in electric apparatus for maintaining a uniform or approximately uniform temperature within a chamber or vessel, specially applicable to incubators.** Alfred Marwood Elton, 46, Lincoln's-inn-fields, London.

13096. **Improvements relating to conduits applicable for combined use as casings for electrical conductors and for gas supply, or for either use separately.** John Alexander M'Mullen, 124, Chancery-lane, London.

13108. **Improvements in the manufacture of metallic boxes or cases for containing electric bells.** Thomas Barton, Bank-chambers, Waterhouse-street, Halifax.

13114. **Improvements in or connected with electric furnaces.** Thomas Parker, 47, Lincoln's-inn-fields, London.

13125. **Improvements in carbon holders and screens suitable for electric welding.** Henry Howard, 24, Southampton-buildings, London.

SPECIFICATIONS PUBLISHED.

1890.

11263. **Electric connections.** Munro. 6d.

12151. **Alternate-current motion.** Siemens Bros. and Co., Limited (Siemens and Halske). 8d.

14155. **Telephonic switchboards.** Fraser and Brown. 8d.

14182. **Telephonic switching apparatus.** Fraser and Brown. 8d.

14686. **Electric lamp carbons.** Lake (Lacombe and Co.). 4d.

1891.

5638. **Electric batteries.** Crowdus. 8d.

7755. **Electric motors.** Lake (The Crocker-Wheeler Electric Motor Company). 8d.

9029. **Electric arc lamps.** Turbayne. 6d.

9241. **Electric railways.** Thompson (Harding). 8d.

9462. **Electrostatic switch, etc.** Alcock. 6d.

9522. **Electromagnetic motors.** Stanley and Kelly. 6d.

9524. **Telephone circuits.** Stanley and Kelly. 6d.

9627. **Thermo-electric batteries.** Abel (Gulcher and another). 8d.

9928. **Galvanic batteries.** Schoth. 4d.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Brush Co.	—	2⅛
— Pref.	—	1⅛
India Rubber, Gutta Percha & Telegraph Co.	10	19⅛
House-to-House	5	5
Metropolitan Electric Supply	—	10
London Electric Supply	5	2
Swan United	3½	4½
St. James'	—	6¾
National Telephone	5	5
Electric Construction	10	7¼
Westminster Electric	—	5

NOTES.

Personal.—Mr. W. M. Mordey has been on a visit to the United States.

Electric Culture.—A farmer, outside Madrid, drives his ploughs by electric motors.

Wath.—The question of electric lighting recently discussed at Wath (Yorks.) has been abandoned.

Morley.—A new town hall is to be erected at Morley, near Leeds. Someone ought to put in the electric light.

Cologne.—A large and important central station for supplying 18,000 lamps in Cologne is expected to be ready to start within the next month.

Utilising the Rhine Falls.—Capital to the extent of over £600,000 has already been subscribed to the scheme for utilising 16,000 h.p. from the Rhine to Rheinfelden.

Manchester Electrical School.—The electrical department of the Manchester Technical School, for the practical training of electrical engineers, will be ready for opening this winter.

Eastleigh.—The lighting of Eastleigh, Southampton, is to be carried out by 64 lamps. The gas company have the matter in hand, but the local electrical men might give the matter their attention.

Submarine Cables.—On the 27th August will be awarded at Paris (103, Rue de Grenelle) the public contract for the establishment of submarine cables (1) between Marseilles and Oran, and (2) between Marseilles and Tunis.

Nelson (Lancs.).—The Nelson Corporation have decided that should 100 tradespeople and others give a guarantee to take the electric light for three years, a scheme for electric lighting will be introduced under the provisional order of 1883.

Sale.—As will be seen elsewhere, a sale "by tender" will take place on August 19th and 20th of a bankrupt stock of electrical appliances, including lamps, wires, switches, instruments, and tools, by Mr. Fredk. Miller, 2, Serle-street, Lincoln's-inn-fields.

Cork.—The Cork Gas Consumers' Company recommend a dividend of 8 per cent., taking £813 from the reserve, which now stands at £11,638, or £578 less than last year. The directors contemplate seeking powers to supply electric light as well as gas.

Rochester Station.—The new works of the Rochester and Chatham Electric Lighting Company are satisfactorily proceeding. New boilers have been fixed, and the engine which was used in supplying the electric current to the Edinburgh Exhibition has been purchased.

River Lights.—The committee reported at the last meeting of the Southampton Town Council that the iron column for high light had been erected, and that the daily lighting and extinguishing of these lights would in future be attended to by the harbour master at a remuneration of £5 per annum.

Dover-Boulogne Cable.—The telegraph cable between Dover and Boulogne is to be relaid and a change made in the course it takes across the Channel, it having been deemed advisable, in consequence of the injury so frequently done to the cable at the base of the Shakespeare Cliff, to take the cable on to Folkestone.

Maidstone.—At a private meeting of the Maidstone Local Board, on Tuesday morning, the question of supplying the town by electricity was considered, and it was resolved to apply to the Board of Trade for a provisional order, and also if possible to put their rights into the hands of an electric lighting company.

Richmond.—The works for the weir and footbridge are now actively begun at Isleworth. If anything is to be done with the idea recently mentioned, of utilising the waters thus dammed back for the generation of electric power, no time should be lost in putting the subject before the Thames Conservancy in a practical form.

Llangollen.—A letter was read from Mr. Graesser, Argoed Hall, at the meeting of the Llangollen Highway Board, asking permission to place up electric wires over the road in Vroncysylltau. The Board agreed to the application on condition that the regulations of the Board of Trade in reference to such matters be complied with.

Beanfeast.—Messrs. Swinburne and Co.'s staff, workmen, and employés had their first annual beanfeast on Friday. They went in a steam launch from Staines to Windsor, where they had dinner. They then came down to Savoy's Weir for tea, and returned to Teddington in the evening, spending a pleasant day in spite of occasional showers.

Electric Woollen Mills.—An interesting item of news comes from Siebnen in Switzerland, where 1,000 h.p. is to be utilised from the River Aar. Of this 400 h.p. is to be utilised in Siebnen, and a new woollen factory to be driven electrically is to be erected by Messrs. Sulzer-Escher, of Zurich. The factory will give employment to 600 workmen.

East African Cables.—The German Government has decided to establish telegraph lines along the whole of the German East-African Coast. Three officials have left Berlin for Bagamoya, where they will, immediately after their arrival, commence the preliminary work in connection with the new lines. Bagamoya and Saadani will be first connected by wire.

More Exhibitions.—Exhibitionists are going to have a wide experience of the world in the next few years. This year Germany, next Palermo, then Chicago. After that Buda Pesth, for we see that it has been decided that an International Exhibition shall be held at Buda Pesth in 1895, the thousandth anniversary of the creation of Hungary as an independent state.

Blackpool.—Some of the Town Council of Blackpool want the electric light at once, others wish to see the scheme kept back six or eight months. The committee who have the matter in hand complained there was so much to do that electric lighting must wait, and was dubbed the "farce committee" for its pains. The report was sent back for reconsideration by a large majority.

Electric Pumps.—The Thomson-Houston Company make electric pumps for supply of water in buildings with motor and force pump, the motor having an automatic arrangement for stopping when the tank is full and starting just before it gets empty. Gould triplex pumps are used with a capacity of 100 gallons an hour, raised 30ft. high, run with a ¼ h.p. motor off the town electric mains.

Barnsley.—The Park and Lighting Committee of the Barnsley Town Council reported on Tuesday that the borough surveyor laid before the committee a scheme and plan prepared by him for the supply of electricity to a smaller area than the one referred to in the Barnsley Electric Lighting Order, and the committee adjourned the consideration thereof until their next meeting.

Holborn.—A letter was read at the last meeting of the Holborn District Board from the City of London Electric Lighting Company, stating that they intended to apply to the Board of Trade next December for a provisional order for lighting the Holborn district, and asking for an opportunity to discuss the matter with a committee of the Board. On the suggestion of the clerk, the matter was referred to the Committee of Works.

Old Students' Party.—A garden party of the Old Students' Association will take place in the grounds of Glebe Lodge, Champion-hill, on Saturday afternoon, September 5, from 3 to 7 p.m. Tickets (2s. 6d.) are to be had on application to the Hon. Sec., 88, Queen Victoria-street, and early application is requested. The meeting will be enlivened with tennis and music, and an enjoyable afternoon is to be expected.

New Cable to Germany.—The laying of a new cable between England and Germany has been completed. The cable was laid between Bacton (a town to the north of Lowestoft), in England, and Emden, in Germany. Herr von Stephan, Minister of Posts and Telegraphs, left Berlin for the latter town in order to attend the arrival of the English cableship "Faraday." The cable is 450 kilometres long, and will cost 2,000,000 marks (£100,000). This is the 12th cable connecting England and Germany.

Electric Heater.—Neat little pamphlets are issued of the Burton electric heater by the Burton Electric Company of Richmond, Virginia, and the Electric Merchandise Company, 11, Adams-street, Chicago. The heaters are now in use in a considerable number of cars at Joplin, Springfield, Indianapolis. The normal current is three amperes, and the extra cost of fuel is inappreciable at the station. The heaters are being applied on steam railways, and a large block of buildings has been fitted with them in the private apartments.

Electrical Standards.—Before the rising of Parliament last week a report was presented by the committee appointed by the Board of Trade to consider and report whether any, and, if so, what action should be taken by the Board under section 6 of the Weights and Measures Act, 1889, with the view of causing new denominations of standards for the measurement of electricity for use for trade to be made and duly verified. The report was accompanied by the minutes of proceedings and evidence, and appendices.

Dublin.—At the meeting of the Dublin Corporation last week, the Lord Mayor moved "that a meeting of the Council be held on the 14th September to consider and take action in reference to making application to the Board of Trade for a provisional order to replace the licence of 3rd May, 1889, empowering the Corporation to supply electricity for public purposes, and that of 24th June, 1890, to supply for private purposes, and to embrace both these licenses and their objects. The motion was seconded by Mr. Healy and adopted.

Newcastle.—Street lighting by electricity is making progress in Newcastle. One after another, our larger open spaces, says the *Newcastle Daily Chronicle*, are being illuminated by means of the arc light. The latest extension in this line is the illumination of the space at the top of Westgate Hill. The arc light fixed there has a brilliant effect on its surroundings. It caused quite a sensation on its first appearance last Saturday night. As compared with the electric light, gas is clearly out of the running as far as the lighting of large areas is concerned.

Transmission of Power in Scotland.—Electric transmission of power is growing—slowly, it is true; but the fact demonstrated and the utility felt, the practice will not linger long before becoming an everyday affair. We are pleased to notice an instance of the kind in Scotland. The Caledonian Mineral Oil Company, at the Lanark Town Council, submitted a proposal to erect poles across the White Lees, and asked for the Council's permission for the transmission of electric motive power to drive a pumping engine at the loch. The permission was granted.

Electric Transmission Hand-book.—Mr. F. B. Badt has already issued several practical hand-books on electrical subjects, and the latest to hand is on electric transmission. Mr. Badt gives a considerable amount of information in a small space on the problems of transmission of power, calculating fall of voltage, efficiency, power of water, and kindred practical problems which the electrical engineer has to face. The hand-book has numerous illustrations and carefully compiled tables. It is published (price one dollar) by the Electrician Publishing Company, of Chicago.

Foretelling Storms.—The telephone, it is stated, can be used with great satisfaction for foretelling storms. By placing two iron bars at seven or eight yards distance from each other, and then connecting them on one side by a copper wire covered with rubber, and on the other side with a telephone, a storm can, so it is stated, be predicted at least 12 hours ahead through a sound heard in the receiver. As the storm advances the sound resembles the beating of hailstones against glass. Every flash of lightning produces a shock similar to that of a stone cast against the diaphragm of the telephone.

Ships' Compasses.—In reply to the remarks in Sir William Thomson's recent letter relating to concentric systems of wiring, Messrs. J. D. F. Andrews and Co., write "to respectfully state that Sir William has not been fully informed regarding our method of wiring, and we would state that we completely fulfil the conditions desired by Sir William by effectively insulating the outer conductor of our wire from the ship's hull in all parts where the compasses are at all likely to be influenced." They add that a more detailed description of their method of insulating the outer conductor was published the week following Sir William Thomson's letter.

York.—At the meeting of the York City Council on Monday, Alderman Agar moved the confirmation of the minutes of the Streets and Building Committee, which stated that the committee had taken into consideration the report of Mr. R. E. Crompton upon the proposed lighting of the city by electricity, which had been printed. The committee resolved that the Electric Lighting Sub-Committee be requested to visit places where the high and low tension system of lighting is in use, and report upon the working of the same. Considerable discussion ensued relating to various street improvements mentioned in the report, and ultimately the minutes were confirmed.

Sims' Electric Torpedo Boat.—A successful exhibition took place on Wednesday at Willets Point, New York, of a new electric torpedo boat just completed for the Government. The requirements of the Government were a speed of 18 miles an hour, with a cable of 11,000ft. These were, however, exceeded, the boat making a speed of 20 miles an hour, and travelling 12,000ft. in six minutes, and carrying a cable 2½ miles long. Mr. Sims, the inventor, conducted the test experiment, under the direction of the military and naval officers, and in presence of a number of invited guests representing foreign governments, all of whom declared the boat to be a complete success.

Bradford.—At the Bradford Town Council meeting on Tuesday, the minutes of the Finance Committee were adopted, including a resolution for the providing and fixing of apparatus for lighting the rooms of the Town Hall by electricity. Alderman F. Priestman, chairman of the Gas and Electricity Supply Committee, presented a statement showing the receipts and expenditure on the gas works account during the half-year ending June 30 last. He said the profits amounted to £6,249, against £6,010 for the same period of last year. There had been an average increase in the price of coal of 1s. 5d. The gas sales had increased by £5,270. The total capital expended on the works was £582,871.

Medical Transformer.—An interesting application of transformers to medical practice is illustrated in the *Lancet* for August 8th. This consists of an apparatus for connection to the ordinary 100-volt alternating-current town mains, constructed by Mr. Schall, of 55, Wigmore-street, W. An 8-c.p. lamp burns over the transformer. Terminals are supplied to the coils, which transform down to six volts, giving a maximum current for cautery of 20 amperes, and a mimimum current of two amperes, and ½ volt can be obtained. Other terminals are supplied for surgical lamps, the power of which can be varied in the same way. The apparatus forms a neat and useful addition to advanced medical practice.

Ulverston.—The Board of Trade have written to the Ulverston Local Board intimating that they proposed to revoke the electric lighting order. The letter, said Mr. Tosh, had caused him extreme disappointment and almost pain. The Board took the trouble seven years ago to obtain a provisional order for electric lighting, and they had since done their best to keep their powers alive, but now they were curtly told by the Board of Trade that they intended to revoke the order. That meant that after spending £150 in getting the order seven years ago they now lost their powers because they had not used them. It was agreed to ask the Board of Trade to wait two months before deciding to revoke the order.

Fatal Fall of an Arc Lamp.—A little girl, Kate Wilkins, aged five years, the child of parents residing at St. John-street-road, Clerkenwell, was the victim of a peculiar accident on the 21st of July, and died last Saturday night at St. Bartholomew's Hospital. A large electric lamp, weighing 28lb., had been suspended outside the Agricultural Hall to advertise "Arcadia," and this, though held by a 38-strand wire, suddenly snapped and fell on the child, who happened to be passing with an elder sister. The child was struck down, and was taken at once in the ambulance waggon to the hospital, where it was found her skull was fractured. The operation of trepanning was performed, but with no good results.

Electric Mountain Railway.—The waterpower at Buochs, which is used by means of electric transmission of power to drive the funicular railway up the Burgenstock, is to be also made to supply an electric railway at Stauserhorn. This line is just begun, and will form a new rival to those up the Righi and Mont Pilatus. A force of 120 h.p. will be available from the dynamo and will be transmitted three miles. The line, which is two miles long, is divided into three sections of equal length, each section acting as a separate line with a motor of 50 h.p. available. The work is to be carried out similarly to the Burgenstock railway. MM. Bucher et Durrer, who are also the engineers to the new railway, have entrusted the electrical part of the work to Messrs. Cuénod, Sauetter, et Cie., of Geneva.

Cables v. Electric Tramcars.—Mr. John Paterson, Chairman of the Edinburgh Northern Tramways Company, speaking on Saturday at the half-yearly meeting, said it was interesting to note that the Birmingham Tramway Company, whose report was just published, stated that the expenditure on the part of their system worked by cables was 50 per cent. of the gross receipts, while the Electric Railway in London, which was originally intended to be worked as a cable system, showed that it was worked at a cost of 77 per cent. on the gross receipts. It was his opinion that the directors of the Electric Railway would regret that they had changed their original intention, and substituted electricity for cables. To give such a judgment within the first year is rash, to say the least of it. "He laughs best who laughs last," and cables are not carrying everything before them.

Crystal Palace Electrical Exhibition. — The directors of the Crystal Palace, in deference to the wish of the Electrical Trade Section of the London Chamber of Commerce, have decided to postpone the opening of the Electrical Exhibition from November, 1891, till the 1st of January, 1892, on which date the exhibition will be formally opened. We understand that the Chamber of Commerce proposed a further postponement, but the directors, anxious as they were to meet their views, could not agree to a later date than the 1st January without breaking faith with a large number of exhibitors who have applied for space, and who are now preparing their exhibits. It will be gratifying to intending exhibitors to learn that, with the view of promoting the success of the exhibition, the Chamber of Commerce have agreed to appoint a large technical committee to act with the directors of the Crystal Palace Company.

The Liverpool Overhead Railway.—The report of the directors states that considerable progress has been made with the works during the past half-year. The main structure is erected as far as the Collingwood Dock; the important opening bridge at the Stanley Dock is completed; and the accommodation works on the northern section are now in an advanced condition. The negotiations with the Corporation of Liverpool for the necessary deviations of the southern section have been concluded, and the directors have pleasure in acknowledging the liberal manner in which their proposals have been met. Sir W. Forwood, presiding at the annual meeting, stated that a contract for the equipment and working of the line by electricity had been made with the Electric Construction Corporation, Limited, of London and Wolverhampton. Two miles of the line have been completed within the last six months, and the railway will probably be opened next spring.

Aberdeen.—The question of utilising tidal power for electric light has again been raised, this time in Aberdeen, by a gentleman of the name of Mr. Evelyn Liardet. The proposal originated in a rather curious manner. The Duchess of Roxburgh, one of the ladies-in-waiting upon Her Majesty the Queen, seems, during her visits to Balmoral, to have gleaned that the Aberdeen authorities have been considering the question of introducing the electric light into the city, and, knowing this gentleman to be interested in such matters, she communicated to him the name of Lord Provost Stewart, and suggested that he might lay his electric lighting scheme before him. Accordingly Mr. Liardet forwarded a pamphlet to the Lord Provost, in which he described his scheme. He asked permission to examine the river Dee with the view of ascertaining whether or not it would be possible to drive electric machinery from the flow of water in the river. A discussion of the problem is arranged.

Southwark.—At the fortnightly meeting of the St. Saviour's Board of Works, held at the Board room, Emerson-street, Southwark, under the presidency of Mr. Baxter, the electric lighting question came under notice. The Paving and General Purposes Committee reported that they had considered the application of the Brush Electrical Engineering Company, Limited, for the consent of the Board to the transfer, pursuant to Section 61 of the

Southwark Electric Lighting Order, 1891, of that undertaking to a company to be formed under the title of the City of London Electric Lighting Company. The Committee now recommended that the Board's consent should be given unconditionally to the transfer of the undertaking, and also to the transfer to the new company of the wayleave agreement between the Board and the Brush Company and the memorandum thereto, dated respectively November 7, 1890, and April 27, 1891. The recommendation of the Committee was unanimously adopted.

Electric Boring.—A vast engineering work is being quietly carried on underneath the streets of Manchester in the reconstruction of the main drainage system. An interesting fact in relation to this scheme is that in the workings a new kind of boring machine has been introduced. This electric borer is the invention of Mr. Kellett, the contractor, and is said to mark a great advance upon other machines of the same kind. It is calculated to bore into the sandstone rock beneath Deansgate at the rate of ¼in. per minute, or 20ft. a day. It will be worked by electricity, with a dynamo of 12-h.p. The machine will consist of a drill and four arms for boring. Each arm is studded with ugly-looking teeth, all of which do their work in tearing and grinding up the rock. As the machine goes forward with its work, the material excavated falls into a bucket ready for removal. It is hoped that the machine will soon be in regular working order; and if it is as successful as is anticipated, similar machines will be placed in other places on the section.

British Association.—The following additional particulars are given of papers promised in Section A, besides the discussion on "Units and the Nomenclature": Prof. Ramsey, "On the Surface-tension of Ether at Different Temperatures"; Prof. W. Stroud, "Some Revolutionary Suggestions on the Nomenclature of Electrical and Mechanical Units"; Mr. W. H. Preece, "Further Researches on the Magnetic Quality of Different Steels on the Modes of Tempering"; Prof. S. P. Thompson (1), "On some Points connected with the Measurement of Lenses"; (2) "On some Experiments with Standard Cells"; Mr. G. H. Bryan, "Report on Researches Relative to the Second Law of Thermodynamics"; Dr. Johnstone Stoney, "On the Cause of Double Lines and of Equi-distant Satellites in the Spectra of Gases"; Prof. G. Forbes, "On the Secondary Compensation of Thermometers"; Mr. J. Swinburne, "The Causes of Variation of Standard Cells"; Mr. F. T. Trenton, "Magnetic Experiments Made in Connection with the Determination of the Rate of Propagation of Magnetisation in Iron."

Electric Trams for Handsworth.—A meeting of the Handsworth Local Board was held on Wednesday, under the presidency of Mr. David Rose. Mr. J. J. Hughes presented the Highway Committee's report, which recommended the Board to sanction the use of steam by the Central Tramways Company for a further period of 12 months on the Birchfield route. Mr. H. Hossell, in seconding the report, said he hoped it was the last time they would have to sanction the use of steam. The company had electric power on the Bristol-road route, and he considered they should insist on the same system being adopted on the Birchfield line. Mr. Hughes said there was no doubt the company had a very serious knock back by the telephone company. He hoped, however, the tram company would speedily surmount the difficulty. Mr. Hossell was of opinion that in the interest of the parish they should take the matter up strongly. The property on the Birchfield route had deteriorated in value 25 per cent. through the abominable nuisance of steam trams. They should do all in their power to get electricity or some other motive power, in order to do away with the nuisance. The report was adopted.

Manchester.—The Electric Lighting Sub-Committee appointed by the Gas Committee of the City Council, we learn from the Manchester papers, have had under their consideration the reports of several consulting engineers as to the proposed installation of the electric light in Manchester. They have decided to recommend the appointment of an electrical engineer, who will advise as to the best system of lighting to be adopted, and will also superintend the operations of the contractor whose tender may be accepted for the work. This gentleman will receive a commission on the cost of the scheme, as is customary in the case of architects. The sub-committee recommend that the "low pressure" shall be adopted, but further details of the scheme will be arrived at after the engineer has been appointed. It is proposed to confine the operations of the committee entirely to a street installation. No apparatus in the interior of houses will be supplied, and those who desire to take advantage of the installation will have to execute their own connections. In this respect the committee's scheme differs materially from the ordinary commercial operations of electric lighting companies.

Reduction in Telephone Rentals.—The Western Counties and South Wales Telephone Company announce important reductions in rentals and an increase of area at the reduced rates for connections to their local telephone exchange systems commencing September 1. Each business or professional connection for lines within one mile radius of the Company's exchange will be charged the following rates: £9 per annum on seven years' agreement; £10 per annum on four years, and £11 for a yearly agreement. Private residences, without business or professional practice, may now be connected to the exchange at rentals varying from £5 to £8 per annum according to distance, not exceeding one mile, from the nearest exchange. Another important feature in connection with the company's rates is that there will be in future no further liability on the part of the renter, as the charges are inclusive of the cost of construction of the lines, erection of instruments, and maintenance of the whole in proper working condition. The directors are prepared to convert the unexpired period of existing subscribers' agreements to the new rates for either of the three periods, provided that the period is not less than that remaining unexpired on the existing contract.

Electric Motors in France.—At Vitry, in France, is a series of wine cellars belonging to the Compagnie L'Orléans. In this are a number of machines requiring power to drive, and the company recently decided to institute a distribution of power by electricity. A Rechniewski compound machine was installed, driven by the works engine. It gives a current of 82·5 amperes at 170 volts for 1,200 revolutions, used partly for power and partly for the entire lighting of the works. The current is received by two motors furnished with resistance stands. The rest of the apparatus is so arranged that whether the motors work or not there is no influence upon the regularity of the light. The lighting is produced by seven arc lamps for eight amperes in the courtyards, and three arcs of six amperes inside; also 10 incandescent lamps of 200-c.p. and 50 of 16-c.p. in the workrooms and stores. Besides this, the same company has installed a complete system of distribution of power in their works at Paris, where it is also used to drive a large drum for washing linen. The power is taken from the engine used to drive a sawmill. An Edison dynamo, 20 amperes and 110 volts compound wound drives a motor with special winding; this is used with gearing to turn the machinery at 75 revolutions a minute, constant speed, notwithstanding what power is required. The conductor used is copper wire of 10 square millimetres, insulated and run in casing where it passes into the interior.

Belfast.—The report of the Gas and Electric Lighting Committee was before the quarterly meeting of the Belfast Corporation last week. The Mayor said the council had appointed a committee some time ago to visit London for the purpose of visiting the installations of the electric light there, not for the purpose of deciding between gas and electric lighting, but to investigate the subject as to the best means of applying the electric light to the district to be lighted in the City of Belfast under the provisional order for the purpose. Following that up, their committee went to a number of stations: Paddington, the Great Western Railway Company's station in the same district, Kensington (High-street), Notting Hill, Brompton, Charterhouse-square, Deptford, and the Westinghouse Company's installation. They would see, therefore, that the committee had not been neglecting their duty. There were some difficulties in the way of that committee reporting fully at present. It was true that they found that the electric light was in practical operation in London, but, at the same time, they were not able to get proper data as to the cost in order to lay a full report before them. Further enquiries were being made in order to complete the report, which would be laid in a few days before them. There was a tendency in the public mind to imagine that because they were going to light a small district of Belfast by electricity that, therefore, all progress in the gas works should be stopped. No greater mistake could be made. The experience of large cities such as Manchester, Leeds, and other places, was that, although they had the electric light in full operation, the consumption of gas was actually increasing every day. He thought it was well for the citizens of Belfast that they should get it out of their minds that for the present at least the electric light was likely to be a successful rival of gas. On the contrary, there existed an urgent necessity for the extension of their present gas works, and they would have to take into consideration, at an early day, how they were going to extend those gas works. He thought they ran a great risk in going through another winter without increase of light. The report, which stated the committee hoped to report further in August, was adopted.

Birmingham Tramways.—At the annual meeting of the Birmingham Central Tramways Company on Tuesday, the chairman (Mr Joseph Ebb Smith) made the following references to electric traction: They were bound, he said, to look forward to the future, and they knew that the abolition of steam traffic was but a question of time. It was useless to blink the fact that in future another form of traction would very probably obtain. But during the whole tenure of his office he had most scrupulously abstained from anything approaching to prophecy, and he bade them take this comfort home with them—that, having regard to the character of the main lines of the city, and having regard to the accounts of the cable department which were now before them, when the time arrived for the reconstruction of the form of traction haulage of the company the present shareholders need not fear or doubt their own position. He did not advocate any rash or sudden change. They had had a period of strain in the past; they asked for the consideration of the local authority and those in power during the period of rest and experiment, and during which they might obtain something like certainty with regard to the results of working any other systems. Whenever it did come, it would be, in his opinion, an advance from solidity of position to prosperity, and not a case of injury to the ordinary shareholder, by reason of the transformation. As to the cost of fuel during the past year, he said it would not be without interest to them if he quoted the comparative increases in the cost of the fuel during the last four years. The fuel which cost 10s. 5d. per ton in 1887 had risen step by step to more than 17s. in 1890-91. Fortunately for them the increase in the cost of fuel had been commensurate with prosperity, increased traffic, and increased profits. In answer to Mr. Whitfield as to the cost of the electric tramway in Bristol-road, the Chairman replied that, roughly speaking, the cost was about £30,000. Mr. Whitfield: What did the cable tramway cost? The Chairman said that, roughly speaking, the cost was about 50 or 60 per cent. more than the electric tramway. Mr. Whitfield: That is about £50,000. The Chairman said he was speaking of the cost of construction, but they must bear in mind the question of working, which was a more intricate subject. The motion for the adoption of the report (which we gave last week) was carried unanimously.

Gaiety Theatre, Dublin.—Ireland possesses in the Gaiety Theatre at Dublin what is described as one of the best appointed theatres in the three kingdoms. Mr. Michael Gunn has recently determined to carry out a very extensive series of improvements, amongst which the complete fitting of the electric light stood foremost. This has been very successfully carried out within four weeks' time, under the supervision of Mr. Harry South, who was engaged by Mr. Gunn for that purpose, and several of his special stage appliances were introduced. The interior is hung with handsome electroliers, fitted with delicately tinted glass flower bulbs. The construction of the entire and complex plant was entrusted to the Electrical Engineering Company of Ireland, and was carried out under their chief engineer, Mr. Porte. Behind the stage entrance is the engine-house, where two Otto gas engines (14-h.p. each) have been erected by Messrs. Crossley and Co., of Manchester. These engines have been specially designed for electric lighting purposes, and are the first of their kind that have been sent to Ireland. They drive two compound wound dynamos built by Messrs. Laurence and Scott, of Norwich. Both engines and dynamos were specially constructed for this contract, and either set is capable of lighting all the lamps that will be in use at one time. The dynamos are driven by cotton ropes. The engine-house also contains very complete switching arrangements, which enable the load to be thrown at an instant's notice from one engine and dynamo to the other without a break, not a flicker being apparent in the 250 lamps of the installation. The roof above presents a curious appearance. It is covered by a network of wires communicating with a switch-board at the side of the stage, which is provided with a series of levers governing the entire lighting system of the house, and with indicators which show the pressure and quantity of the current. From this point the lights employed for all stage effects are controlled. Resistances have been arranged so that it is possible to lower the lamps in different degrees from full power to a mere glow, and the turn of a handle upon a circular plate reduces the number of footlights, so that any conceivable quality of illumination is producible at will. To this part of the installation Mr. Gunn, who is himself an electrician of some experience in connection with the lighting of the Savoy, has given particular attention, and the system is considered as perfect as it is possible for modern scientific skill to render it. The whole of the work reflects the highest credit upon those engaged in it. The machinery had to be built, the switching arrangements designed and made, and the entire plant perfectly fitted in three weeks after the order was received. All hands worked night and day and no labour was spared. The trial on Saturday was a great success.

ON A TEST OF EWING AND MACGREGOR'S METHOD OF MEASURING THE ELECTRICAL RESISTANCE OF ELECTROLYTES.[*]

BY PROF. J. G. MACGREGOR, D.SC., DALHOUSIE COLLEGE, HALIFAX, N.S.

Some time ago Prof. Ewing and I published a paper[†] on the electrical conductivity of certain saline solutions, in which we gave the results of observations of the resistance of electrolytes by a very simple method, requiring no elaborate apparatus, and capable, therefore, of being applied at a moment's notice in any laboratory provided with the usual outfit of galvanometers and resistance coils. Shortly after the publication of our paper it was sharply criticised by Prof. Beetz,[‡] who endeavoured to show that the method was defective and the results untrustworthy. In reply,[§] I showed that he had completely misunderstood our method, and that the data on which he based his condemnation of our results were insufficient. Subsequently, Prof. F. Kohlrausch[||] subjected our method to criticism, expressing the opinion that the kind of galvanometer which it demanded was incapable of construction, and pointing out that his results differed from ours, in cases in which we had experimented with the same salts, by various amounts ranging from 0 to 12 per cent. I have not the slightest doubt that Prof. Kohlrausch's results are far more accurate than ours. For apart from the undoubted trustworthiness of his method, he is an experimenter whose ability and experience have long ago been placed beyond question, whereas at the time of the publication of our paper Prof. Ewing and I were both students, and possessed little of the power of avoiding errors which only experience can develop. But while it may be regarded as practically certain that our results were by no means exact, it has always seemed to me to be doubtful if Prof. Kohlrausch's opinion, that a galvanometer such as our method requires was incapable of construction, was well based. And as our method is simple, and if trustworthy would be very convenient for ordinary laboratory work, I have thought it well to test it.

As the method refered to has been apparently misunderstood and certainly inaccurately described even by such exact authors as Prof. G. Wiedemann[¶] and Prof. Chrystal[**], it seems probable that our description of it must have been defective. It may therefore be well for me to describe it anew before referring to the test which I have recently applied to it.

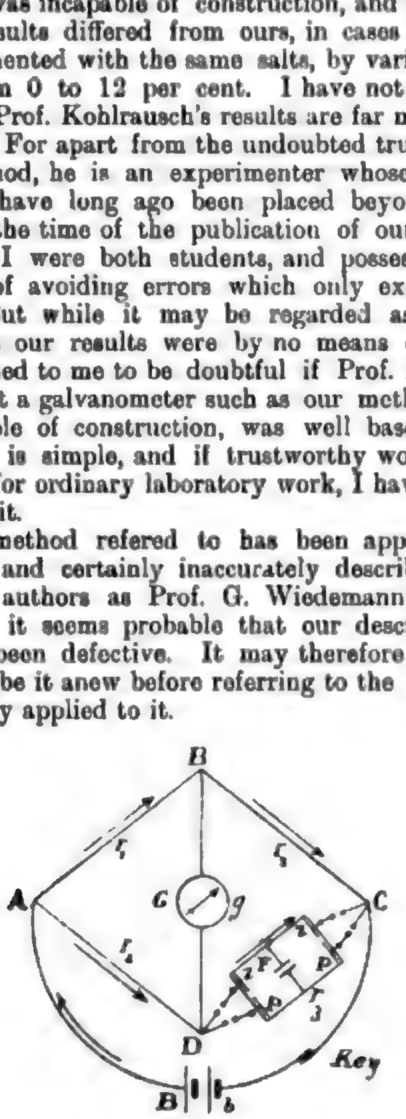

FIG. 1.

Let A B, B C, C D, D A, B D, and A C, Fig. 1, be six metallic conductors with similarly named ends connected, of which A C contains a voltaic cell or battery of E.M.F., E, so inserted as to send a current, say, from A to C through B and D. Then, as is well known, it may be shown by means of Kirchhoff's equations that if G is the strength of the current flowing in B D, and r_1, r_2, r_3, r_4, g and b the resistances of A B, B C, C D, D A, B D, and A C (including that of the battery), respectively, we have

$$G = E\,(r_2\,r_4 - r_1\,r_3)\;/\;b\,g\,(r_1 + r_2 + r_3 + r_4) + b\,(r_1 + r_4)(r_2 + r_3) + g\,(r_1 + r_2)(r_3 + r_4) + r_1 r_3\,(r_2 + r_4) + r_2 r_4\,(r_1 + r_3).$$

It follows that G and $r_2\,r_4 - r_1\,r_3$ must vanish together, and upon this result the measurment of the resistance of metallic conductors by means of Wheatstone's bridge depends. A key is inserted in A C so that the current may be allowed to flow through the system of conductors as often as may be desired. A galvanoscope is inserted in B D so as to indicate whether or not a current is flowing through that branch. The conductor whose resistance is to be determined is made one of the "arms" of the bridge, A B, B C, C D, or D A, and the resistances of one or more of the other arms are then adjusted until on sending the current through the system, the galvanoscope gives no indication. Since in that case $r_2\,r_4 - r_1\,r_3 = 0$, and three of these four quantities are known, the fourth may at once be determined.

The determination of the resistance of an electrolyte is not in general so simple, because it can be connected with the other conductors as one of the arms of the bridge, only by means of electrodes. These electrodes must be of a substance on which the electrolyte has no chemical action, and in most cases should therefore be of platinum. But no sooner does the current pass through an electrolytic cell with platinum electrodes than they become polarised, and the electrolytic cell becomes in fact a voltaic cell, with an E.M.F. which increases from the value zero to a certain maximum value, and which tends to send a current in the direction opposite to that of the polarising current.

In one very important case, that of an electrolytic cell containing solution of zinc sulphate of proper strength, with amalgamated zinc electrodes, a current produces no polarisation, and as my experiments[*] have shown that there is also in this case no appreciable transition resistance, the resistance of solutions of this salt may be determined as exactly and as simply, and by the same method, as that of metallic conductors.

In general, however, platinum electrodes must be used, and if an electrolytic cell with these electrodes be inserted in one of the arms (say C D) of the bridge, we have, as soon as the current begins to flow, an opposing E.M.F. in C D, and therefore the expression for G given above no longer applies. Let e be the value of this opposing E.M.F. due to polarisation, at any given instant after the current has begun to flow, r_3 being the resistance of the electrolytic cell and the wires by which it is connected to C and D. Then it is easy, by writing down Kirchoff's equations, to show that

$$G = E\,(r_2 r_4 - r_1 r_3) - e\,[b(r_1 + r_4) + r_4(r_1 + r_2)]\;/\;bg(r_1 + r_2 + r_3 + r_4) + b\,(r_1 + r_4)(r_2 + r_3) + g\,(r_1 + r_2)(r_3 + r_4) + r_1 r_3 (r_2 + r_4) + r_2 r_4\,(r_1 + r_3).$$

The second factor of the second term of the numerator, and the denominator, of this expression, are essentially positive quantities, and E and e change sign together. Suppose now that the resistances of the arms of the bridge are so adjusted that $r_2\,r_4 - r_1\,r_3$ has a finite positive value, then at the instant at which the current begins to flow through the system, e being zero, G has a positive or negative value according to the sign of E. As time goes on e increases, and therefore G diminishes numerically. After a certain time, provided that the resistances of the arms and the maximum value of e are such that we may have

$$e\,[b\,(r_1 + r_4) + r_4\,(r_1 + r_2)] > E\,(r_2\,r_4 - r_1\,r_3),$$

G becomes zero, and ever after that G will be negative if it was positive before, and positive if it was negative before. In short, provided $r_2\,r_4 - r_1\,r_3$ has a positive value, the current through B D flows first in one direction with gradually diminishing strength, and then in the opposite direction.

With a battery of given E.M.F., the greater the value of $r_2 r_4 - r_1 r_3$—*i.e.*, the farther the arms of the bridge are from the adjustment, which, for $e = 0$, would give no current in B D, the longer is the time in which G has the same sign as at the instant at which the current begins to flow. If this value be made small, that time becomes small; and if the resistances be so adjusted that $r_2\,r_4 - r_1\,r_3 = 0$, the current through B D flows at the outset in the same direction as subsequently.

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[*] A paper read before the Royal Society, Canada.

[†] "Trans. Roy. Soc. Edin.," Vol. xxvii. (1873), p. 51.

[‡] "Sitzunberger. d. Müunchener Akad.," 1875, p. 59, and "Pogg. Ann.," Bd. cliv. (1875), s. 450.

[§] "Proc. Roy. Soc. Edin.," 1874-75, p. 545.

"Wied. Ann.," Bd. vi. (1879), s. 32.

[¶] "Die Lehre von der Elektricitit," Bd. i., s. 589.

[**] "Encyclopædia Britannica," 9th Ed., Art. "Electricity," p. 50.

[*] "Trans. N. S. Inst. Nat. Sci.," Vol. vi. (1882-83), p. 47.

If now we had a galvanoscope which would respond instantaneously to any change in the current flowing through it, so that at any instant it would indicate the direction of the current flowing through it at that instant, and if it were inserted in B D, it would be possible to make an exact determination of the resistance, r_3, of the electrolytic cell. It would only be necessary first to get the resistances of the arms so adjusted that on passing the current the galvanoscope would give a double deflection indicating a current first in one direction and then in the other, and next to change step by step the adjustment of the resistances of the arms until on passing the current the deflection would just cease to be double. For the adjustment of resistances with which the deflection of such an instrument would just cease to be double is, as we have seen, such that $r_2 r_4 - r_1 r_3 = 0$. A galvanometer of the ordinary form, but with a mirror and magnet of indefinitely small moment of inertia, hung by a fibre offering no resistance to torsion would form an instrument of the kind required. But such a galvanometer is, of course, ideal.

With an actual galvanometer in the bridge, having a magnet and mirror with finite moment of inertia, no appreciable motion of the magnet can be produced until the current has acted for a certain time. Obviously, therefore, if we start with such an adjustment of the resistances in the arms, that this instrument gives, on the passing of the current, a double deflection, and if we gradually change the adjustment until the double deflection just vanishes, we may be sure that $r_2 r_4 - r_1 r_3$ has still a positive value. With a magnet of small moment of inertia it may be small, but it will still have a value. And if the vanishing of the doubleness of the deflection were the only observation which could be made, it might not be possible with any magnet and mirror yet manufactured to make this value small enough to be neglected. But it will be obvious that, if the resistances of the arms have been so adjusted that on passing the current the deflection has just ceased to be double, then during the time which elapses before an appreciable motion of the magnet occurs, it has first received an impulse in one direction and subsequently another impulse in the other direction, and the motion in this direction is due to the resultant of these. Hence the magnet does not begin to move immediately after the current begins to flow, but for a certain time remains at rest. And this will be the case so long as $r_2 r_4 - r_1 r_3$ has a positive value. Hence even an ordinary galvanometer which, when $r_2 r_4 - r_1 r_3$ is small, is not sensitive enough to give a double deflection, will exhibit a hesitation at the beginning of its single deflection. As the value of this quantity becomes smaller and smaller the hesitation diminishes, and the difficulty of observing it of course increases. But, obviously, if we adjust the resistances until there is not only no double deflection but also no hesitation, we get $r_2 r_4 - r_1 r_3$ more nearly equal to zero.

Whether or not with any given galvanometer we are justified in assuming $r_2 r_4 - r_1 r_3$ to be practically zero when the adjustment of resistances is such that the hesitation above referred to can just not be observed, can only be determined by experiment. The mirror (with magnet) of the instrument which Ewing and I used weighed 0·03 gramme, and its diameter was 8 mm. Its moment of inertia, therefore, was exceedingly small, so small that we considered ourselves justified in making this assumption.

It will be obvious from the above, that it is not necessary, in applying the method under consideration, that the currents, which are passed through the cell to test the adjustment of the resistances in the arms of the bridge, should be momentary. So far as any one observation is concerned the current may be allowed to pass for any length of time. But as the next succeeding observation cannot be made until the polarisation produced by the former has died away, and as the passage of the current changes the constitution of the liquid in the cell, it is for these reasons desirable that the current should be allowed to pass for as short times as possible.

With regard to the practical working of the method it must be noted that it is difficult to obtain platinum plates which, when used as electrodes, do not themselves constitute a voltaic cell. In the experiments which I have recently made I found it quite impossible. My electrolytic cells were in all cases found to be voltaic cells of small and practically (apart from polarisation) constant E.M.F. If we call $\acute{e}$ the E.M.F. of the electrolytic cell due to the electrical difference of the electrodes, it is easy to show that we have for the strength of current through the galvanometer,

$$G = E\,(r_2 r_4 - r_1 r_3) - (e \pm \acute{e})\,[b\,(r_1 + r_4) + r_4\,(r_1 + r_2)]\;/\; b\,g\,(r_1 + r_2 + r_3 + r_4) + b\,(r_1 + r_4)\,(r_2 + r_3) + g\,(r_1 + r_2)\,(r_3 + r_4) + r_1 r_3\,(r_2 + r_4) + r_2 r_4\,(r_1 + r_3).$$

If now $r_2 r_4 - r_1 r_3 = 0$, then, at the instant at which the current begins to flow, e being zero, we have, if for the denominator of the above expression we write d,

$$G = \pm\,\frac{\acute{e}\,[b\,(r_1 + r_4) + r_4\,(r_1 + r_2)]}{d},$$

$$= \pm\,\frac{\acute{e}\,r_1}{g\,(r_1 + r_2) + r_2\,(r_1 + r_4)},$$

which is independent both of E and of b. If, therefore, we had a galvanometer with a mirror of indefinitely small moment of inertia, we might proceed exactly as we would if $\acute{e}$ had the value zero. With an actual galvanometer, however, it is obvious that the adjustment of the arms which will just give no double deflection, or no hesitation at the beginning of the single deflection, will not be exactly the same as it would if the electrolytic cell were not behaving as a voltaic cell, for the first appreciable motion is due to the integral effect of the superposed currents due to three sources of E.M.F. In such cases, however, it is comparatively easy (though it increases the time necessary to make a determination of resistance) to produce, before each step in the adjustment of the arms, a polarisation in the cell, whose E.M.F. is equal to $\acute{e}$ and of opposite sign. For this purpose a current is sent through the cell in the proper direction long enough to produce more than the required polarisation. As this polarisation slowly dies away, there will be a short time during which the E.M.F. due to the polarisation will just neutralise $\acute{e}$, and in that short time the adjustment of the arms may be tested without error due to $\acute{e}$.

It is obviously desirable that in applying this method, the E.M.F. due to the polarisation of the electrodes should be as small as possible; and the satisfaction of this condition requires (1) that the electrodes should be as large, and (2) that the current through the electrolyte should be as weak as possible.

The size of the electrodes will in general be determined by the cell to be used. If we wish to determine the specific resistance of a liquid, of which we have a large quantity, we may take them as large as we please. But, if we wish to determine the resistance of a given electrolytic cell, their area may require to be small. In that case it may be necessary to platinise them after the manner of Kohlrausch* and Grotrian. Whether or not platinising may be necessary depends upon the sensitiveness of the galvanometer at our disposal, and can be determined only by experiment.

If the polarisation produced in the electrolytic cell be found to be too great to give good results, the current through it may, of course, be weakened either by diminishing the E.M.F. or increasing the resistance of the battery used, or by proper adjustment of the resistances in the arms of the bridge.

The adoption of any of these means of reducing the polarisation, however, will, in general, diminish the sensitiveness of the bridge; and thus a happy mean must be struck between the conditions which must be satisfied to keep down polarisation, and those which must be satisfied to keep up sensitiveness. This happy mean can be selected in any given case only by experiment. We can recognise the fact that we have hit it by the degree of facility with which we can distinguish between the adjustment of the arms giving an obvious hesitation at the beginning of the single deflection, and the adjustment giving obviously no hesitation. If it requires a considerable change in the adjustment of the arms to produce the change from obvious hesitation to obviously no hesitation, the current through the cell may be known to be too strong, and must be reduced in such a way as to diminish the sensitiveness of the bridge as little as possible. I have found more difficulty in securing sufficiently low polarisation in the electrolytic cell when its resistance was low than when it was high. But this was obviously due to the fact that my box of coils was a very small one and admitted of but very slight change in the resistances of two of the arms of the bridge. With adequate appliances I see no reason why the method should not be as readily applicable to cells of low as to cells of high resistance.*

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* "Pogg. Ann.," Bd. cliv (1875) s. 7.

It will be obvious that the resistances given by this method must be too high, for when hesitation can no longer be observed we have the arms so adjusted that

$$r_2 r_4 - r_1 r_3 = k,$$

where k, though small, is a positive quantity. Hence, the resistance of the cell,

$$r_3 = \frac{r_2 r_4 - k}{r_1},$$

and is therefore really less than it seems to be when we assume k to be zero.

(To be continued.)

IS "EARTH" OF ANY VALUE AS THE TERMINATION OF A LIGHTNING CONDUCTOR?

BY SYDNEY F. WALKER.

Students of Dr. Lodge's researches and lectures on the subject of lightning and its efficient discharge will remember that one of the great points he first made in his able attack upon the old methods was, that "earth" was of no value whatever. The utmost that he would allow after the discussion at the B.A. meeting at Bath was that "earth" might not be a bad thing. In one of his first lectures on the subject he pithily summed up the argument thus: "Why need lightning make any trouble over a few feet or a few yards of earth, when it has already come through several miles of air." It must be confessed that, put in this way, the argument looks convincing. It has been the writer's opinion, however, from the first that "earth" played a very important part indeed in the matter of the effective discharge of a thundercloud, but that the whole thing turned upon the question what is "earth" for a lightning flash? In a previous article he has endeavoured to show that proper "earth" is by no means a simple matter, even when we know to a very much larger extent what we are dealing with than we do in the case of a highly-charged cloud discharging to the buildings or other objects below it. For the first time in his 17 years' experience the writer has felt our pressing want of knowledge of what electricity is. When we are sending an electric current from London to Manchester to work a telegraph apparatus there we know that, whatever that current may be, and whether the conductor be a metallic wire, as we view it, or an elongated elastic bag, as Dr. Lodge's latest theory of electricity would picture it, some path having the same properties as the wire by which the current went to Manchester must be provided to bring the same current back to London, or the apparatus at Manchester will not work. The current may go round by Glasgow, Douglas, even New York, or by any route that nature provides, but come back it must, subject only to the conditions of Ohm's law. But with a thundercloud apparently there is no such necessary connection. We see the cloud, dark and ominous—in this country, at any rate—gathering overhead; we see the flash, we hear the roar, and sometimes we find that some chimney has been struck and thrown down; sometimes a monarch of the forest has been riven in two, leaving a blackened trunk in place of the previously healthy tree; sometimes, again, an innocent sheep, or an ox, or even a man receives the flash and may fall dead. Apparently there is no connection here with "earth" or "ground" as we understand it in connection with the distribution of electrical currents for useful purposes. The vagaries of lightning—how it strips a man's foot off, leaving the other sound, how it prefers to go through a brick or stone wall to running down the conductor provided for it, etc.—will be fully dealt with in another place. The question now proposed to be discussed, is merely this one of what effect "earth" has on the discharge. Seeing the apparently uniform behaviour of lightning, the idea of the earlier electricians that all that was required was to provide a safe path to a safe earth, is hardly to be wondered at. Apparently the lightning flash always seeks "earth," though it may be by way of the body of an animal, or the mass of a building, so that all that should be required should be to give it plenty of room in transit and a comfortable bed on its arrival. As the writer pointed out in the discussion on the subject at Bath, the problem involved in the safe discharge of a thundercloud is closely analogous to that involved in dealing with the huge reservoirs which supply our large towns with water. If the water is allowed to overcome its dam, it pours down the valley, carrying all before it. If it is made to dribble down, it not only does no harm, but is useful. A lightning conductor may be said to fill the same office that a channel made for the water leading directly to the sea would, if it were possible and so arranged that the whole of the water in the reservoir could be allowed to run harmlessly down this channel immediately there were signs of the dam being likely to give way.

The idea of discharging a thundercloud is taken evidently from the old idea mentioned in the previous article on this subject—viz., that Mother Earth is a reservoir of infinite capacity for electricity, just as she is for water. Immediately this idea is given up the apparent use of "earth" is gone. So far as can be seen, there is no return path necessary when a discharge from a cloud kills a man or shatters a chimney. Lightning surely knows its own way about, and if it does not require "earth" in such a case, why provide "earth" at all? Further, Dr. Lodge professes to have discovered cases in which buildings have been struck which were properly protected by lightning conductors of the most approved modern type. On this point, however, there is a difference between Dr. Lodge and those who uphold the old form of lightning conductor. At the Bath meeting Dr. Lodge was challenged to give any instance where a building had been struck when fitted with a conductor properly fixed, properly pointed, and properly "earthed."

In his reply, Dr. Lodge palpably begged the question. "Whenever a building was struck," he said, "electrical engineers always declared that the conductor, if it had one, was not a proper one, or was not properly 'earthed.'" Though this answer practically admits defeat on the professor's part, it is hardly satisfactory to allow the matter to rest there. We want to know why these cases occur, and though Dr. Lodge may not be able logically to defend his position, we are still very much obliged to him for raising the whole question, and for throwing the light he has upon it. This action has taken the whole thing out of the old rut in which it had laid for so long. The question comes back then to this, what office are we to say that earth now fills with our enlightened views of conductors, and of the part that earth plays as a conductor? Is it correct, as Dr. Lodge asserts, that it performs no useful office; that it, perhaps, leads the lightning discharge into places where it may do real damage that would otherwise be avoided? Unfortunately, the conductor, and even its earth terminal, do lead lightning currents often into places where damage results. In the writer's opinion, however, earth does perform a useful office in connection with the discharge of lightning, even in view of our advanced knowledge of the subject; and he believes that the solution of the apparent paradox will be found to be the same as that of "Tam's" difficulty with his frictional machine, that was referred to in the previous article. It will be remembered that, according to the writer's view, "Tam's" failure was due to the exceedingly dry state of the atmosphere, during that particular season, having so increased the resistance of the connection between one pole of his frictional machine, the earthed pole, and the other side of the inductive circuit—viz., the walls of the room, etc. But if this is correct—and if it is not, the writer would be very glad to hear other views on the matter—does it not apply equally to a thundercloud? What is a thundercloud but a huge generator of electricity? A ictional or hydro-electrical machine on an enormous scale? not the reason, too, that no discharges take place under rtain conditions, while they are frequent under other nditions, merely that the resistance of the circuit in the e case is so great that no discharge can take place, while the other it has been reduced to within such limits that spark can pass at some point? Consider the conditions little closer. When do lightning discharges usually occur? it not when the atmosphere is full of moisture, drawn om the ground below by the intense heat of summer? nd does not the same cause tend to reduce the resistance another way—viz., by lessening the distance between the louds and the earth, the heavy mass of vapour tending to pull down? Next consider what happens when a cloud becomes harged. The writer is afraid that, with all due respect Dr. Lodge, he must leave the elastic bags to take care of hemselves, and revert to the reasoning that is common in ther branches of electrical science. If a cloud becomes harged then, work is done upon it. It is capable of doing vork in return, and will do that work if favourable condi- ions arise. Further, if a cloud, or one part of a cloud, ecomes charged, say positively, it is implied that a nega- ive charge exists elsewhere. Would it not be better to ut this fact in the practical form in which electrical engi- eers are accustomed to deal with phenomena comprising the reation or the expenditure of electrical energy, and say that n E.M.F. is created between certain parts of the cloud and ther objects; probably other portions of its own mass being ncluded in the phenomena If the E.M.F. existing between point in the cloud and any point in surrounding objects be ufficient to overcome the electrical resistance opposed to it, hen a current passes, varying in form according to the con- litions present; such, for instance, as the rate at which the pposing resistance is lowered, etc. Probably minute, armless, possibly health-giving electric currents are always assing between cloud and cloud, and from individual louds to the earth. But in order that a current shall pass, we know that the whole resistance of the circuit must be such as will allow of its passage, not that of one small portion. It is well known that a shock of high voltage may be taken from a frictional or induction machine without danger, where the same voltage applied to the body from a dynamo used for electric lighting would cause instant death. The explanation is, that though the resistance of the body is the same in the two cases, or nearly so, that of the other portions of the circuit—in particular the internal resistance of the machine itself—is enormously greater in the one case than in the other, so great, in fact, as to absorb or use up a large portion of the E.M.F. generated before any current reaches the external circuit. Electrical engineers know what it means to have a dynamo or a battery whose internal resistance is out of proportion to that of the apparatus to be worked. Take, for instance, a battery of 10 cells, each having an internal resistance of 10 ohms, while that of the line and apparatus outside is only one ohm. As we know, we practically get no current from such a combination; and we should get none from it if we had 100 or 1,000 similar cells. And so it is with the Holtz machine, and with the thundercloud.

But what is the circuit which governs the discharge of the thundercloud? It is assumed that the cloud acts only as one plate of a condenser or Leyden jar, the earth forming the other; that the cloud, once charged, may be looked upon as cut off—just as one may charge a Leyden jar and have done with it. Obviously, this is an incorrect description; and it is only fair to Dr. Lodge to mention that in his experiments he does not appear to take this view. It is evident, of course, that a charged cloud fills the same, or nearly the same, position with regard to surrounding objects that a frictional machine does. It is a generator, and at the same time it forms one side of the condenser, of which the earth and other clouds form the other. But it must not be forgotten that while there is an *inductive* connection—if it may be so termed—between the cloud and surrounding bodies, there is also a *conductive* connection, and that the office of the inductive connection is only to determine the positions of strains, or of E.M.F's.

Consider, again, what happens when a charged cloud sails over a particular portion of the earth's surface. Probably, during its motion, its charge is being increased by friction with the atmosphere. We know, also, that assuming one extremity of the cloud to be charged positively, the earth and other objects near will be charged negatively. At any rate, there is an E.M.F. existent between them, similar to that existing, say, between the terminals of a dynamo; and if we examine surrounding objects, we shall find that they display characteristics which we associate with a charge of a certain name, opposite in character to that of the inducing body, the cloud. But, assuming this to be correct, how did the charge reach the objects named? We know, for instance, that the nearer objects will be more highly charged than those more remote, and we know that this charge means—unfortunately this is where we want a little more light. At any rate, we do know that the induced charge, whether positive or negative, has only been allowed by conduction from surrounding objects. That is to say, when, in obedience to the inducing force exercised by a highly-charged thundercloud, the top of a factory chimney, say, becomes positively electrified, or there appears a difference of potential between it and not only the cloud, but surrounding bodies on its own side of the condenser dielectric, this state has been arrived at by means of electric currents passing from these surrounding bodies, and possibly from the cloud itself, to the chimney-top. When also, owing either to the departure of the cloud, or to its whole or partial discharge, the strain is relieved at that particular point—in other words, the difference of potential is lowered, and a redistribution takes place—this also will be by means of currents of electricity, as we understand them. Further, when a discharge between a thundercloud and an object attached to earth takes place, be that object a mill chimney, a Royal palace, an oak, or an animal, the discharge, be it harmless or disastrous, must be by means of one or more electric currents, taking the term in the sense in which we now understand it.

The point whether a Leyden jar discharge, or a lightning discharge, be by continuous or oscillatory currents, in the writer's opinion hardly affects the question. If the discharge is oscillatory, it will be so because under certain conditions, an opposing E.M.F. is created in the process of first discharge, which in turn delivers its current along the path or paths open to it. Nor can the question whether a conductor of large sectional area offers the resistance that Ohm's law would dictate, or offers a higher apparent resistance owing to induction within itself, affect the argument. It may at once be acknowledged that a copper rod, or rope, or tape may be considered for the purpose of the passage of an electric current through its mass, as composed of a bundle of rods of infinitely small sectional area, and it is obvious that if this is so, and there is no reason to question the premise, the current passing in each of these rods or wires acts inductively upon those passing in all the others, and in such a manner as will resist their passage; because, as we know, each current creates around it a series of circles of magnetisation within which the others would be enclosed, and these resent, so to speak, the entrance into them of another current creating magnetic fields of a similar name. Further, we know, by the laws of magneto-electric induction, that these effects, giving rise to apparent resistance, are proportional to the current strength, other things being the same. We know also that in all these cases the current strength depends upon the E.M.F. available, and inversely upon the resistance of the circuit. In other words, the whole thing depends upon the difference of potential between the cloud and the top of the conductor, and inversely upon the resistance of the path or paths chosen, *nolens volens* by the discharging current, so that we come right back to our initial question—What is the path of the discharging current? and what part does "earth" play in the discharge? The apparent increase of the ohmic resistance of any lightning conductor, owing to magneto-electric induction within itself, would really appear to be too small a matter, considering the magnitude of the figures involved, to have any serious bearing upon the question. Here it may be well to state another problem for solution. It is the problem of which the question, "What part does 'earth' play in a lightning discharge" forms a part. It is, what is necessary to protect buildings, electrical instruments, such as telephones and dynamos, or trees and animals from being struck by dangerous lightning discharges. The answer is, in the writer's opinion, that the E.M.F. available for driving a current through the body to be protected must be reduced below the dangerous point, or below that at which either a dangerously powerful heating or shocking current, or a dangerously powerful spark, can be delivered through the circuit of which the body to be protected forms a part.

It is obvious that this end may be accomplished in two ways only—viz., by interposing in the circuit which it is designed to protect a high resistance, or by shunting the circuit by means of a conductor of such low resistance that the shunted current lowers the E.M.F. at the terminals of the body or instrument to be protected below the danger point. Possibly an example taken from practical electrical engineering work will make this clear.

Suppose that you have an electrical pumping plant which is being worked at an E.M.F. in the mains of 300 volts or thereabouts, and you wish to run incandescent lamps on the same circuit; you have only 100-volt lamps, and the problem is therefore to use these lamps without overheating them. The problem, of course, is a very simple one. You either use three of the lamps in series, or where you cannot use three lamps together within any reasonable distance, you introduce an artificial resistance between one main and one terminal of the lamp. In either case you use up the surplus 200 volts by introducing the additional resistance, reducing the E.M.F. at the terminals of the lamp to the figure you require, 100 volts, thereby only allowing the proper current to pass through it. But you might also have accomplished the object by causing a large current to pass through the mains and through another branch circuit, the current passing being of sufficient magnitude to reduce the voltage at the terminals of the lamp to the same figure as before—viz., 100 volts—by reason of the charge made upon the initial E.M.F. present for the passage of this current through the mains, in opposition to their electrical resistance.

Take the resistance of the mains between the terminals of the dynamo and those of the motor at one ohm, and the normal working current as 20 amperes; the E.M.F. at the terminals of the dynamo being 320 volts, giving 300 volts at the terminals of the lamp. Now bridge across the mains at a point near where you require the lamp with a shunt, having a resistance of 1·5 ohms, which will allow of the passage of a current of 200 amperes. Making use of the usual formula $E = C R$, we find that the passage of this current through the mains absorbs 200 volts, and the E.M.F. at the point where the shunt is connected, while the shunt current is passing, will be only 100 volts.

The above is, of course, only a hypothetical case, though it might occur under such conditions as the waste of power in the mains being of no consideration even when of the large magnitude described, and the shunt circuit might be represented by a motor using that current. Such a case might also arise from defective engineering. The example, whether hypothetical or practical illustrates the two methods that rule for protecting life and property from the current of a high-tension supply, or from lightning.

The first method, the introduction of an artificial resistance into the circuit, is that usually adopted by attendants upon high-tension dynamos, when they place a piece of dry wood near the machine to stand upon while they are oiling, etc., when the machine is running. The second plan is the one that has hitherto been adopted almost universally in the matter of lightning conductors, but which, as the writer understands the matter, Dr. Oliver Lodge says is wrong.

The first plan is also obviously one that could be adopted in case of being caught in a thunderstorm. If one knew where to stand upon a piece of close rock, which itself stood upon ground that did not hold moisture readily, one would have accomplished the object sought after—viz., by introducing an artificial resistance into the circuit, lessened the chances of a dangerous current passing through one.

It will be evident, however, that whichever plan is chosen the return path is a matter of considerable importance. In the example that has been chosen the return path is a cable or other conductor; and the question will arise here, Is a return path necessary in the case of lightning? The writer maintains that lightning requires a path for redistribution of its charge, for the expenditure of its stored energy, just as much as either an electric light supply system requires one, or a frictional electrical machine does. But consider, first, what would be the effect of having a return path of high resistance in the case where you propose to take off a powerful shunt current for any purpose. Your high-resistance return path will prevent your doing it, because you will be unable to get the necessary strength of current through.

It must be remembered that in dealing with protection from lightning the two classes of cases must be kept quite distinct. If an object is already protected, by the fact that from its position a high resistance is offered to any current that can be sent through it from a thundercloud, it requires no other. But, on the other hand, if the object to be protected stands in such a position that the natural resistance offered to the current that would be sent through it from a thundercloud is not sufficient to protect it under all circumstances, and it becomes necessary to protect it by the other plan, then the high resistance of the return path is an obstacle in the way of accomplishing this. And it is here that the necessity for good, very good earth, appears to the writer to come in.

What is the return path, or, if it be preferred, the path for redistribution of the charge on a thundercloud? The charge would, as already stated, probably be formed in the process of the formation of the cloud itself, and by friction with the atmosphere as it sailed over the earth. Whence did this charge come? Evidently principally from the moisture in the surrounding atmosphere, a little from the air itself. But the fact of a charge of electricity having been taken from the atmosphere between the cloud and the earth would cause a current from the earth, and from buildings, animals, chimneys, etc., producing the phenomena we know to exist—viz., the charge of an opposite name on those portions of the earth's surface, and the objects upon it, immediately under the cloud. When a redistribution takes place it can only be by means of currents passing through the conductors present. The method of redistribution will, of course, depend upon the conditions ruling at the time. Thus the effect of the discharge of one cloud might be neutralised by the presence of another, and the discharge of the cloud might take place not to any object upon the earth, but to another cloud, in which case quite a different set of conditions would be set up. Again, the cloud might not discharge at all in the neighbourhood where it was generated, and where it acquired the major portion of its charge.

In any case, however, whatever the cause of the redistribution, it could only take place by *conduction*. Now, consider, if this true, what it means. It does not mean that only metals, or the inside of chimney shafts, or wet trees, or animals will take part in the redistribution, but that these and every other body which lies in the path of the E.M.F. present will take its proportion of current according to Ohm's law—*i.e.*, in inverse proportion to their resistances. It should be mentioned here that there will probably be electromagnetic induction between different portions of the discharging or redistributing current, when passing through earth, rocks, trees, or any other body, just as there will be between the different portions passing through a lightning rod. There will also be electrolysis set up at different points, both giving rise to counter E.M.F.'s, and the current passing in any path will be ruled by the final E.M.F. available for overcoming the resistance of that path, after allowing for these counter E.M.F.'s, just as the current passing in an electric motor would.

Now it will be evident that as the mass of the earth's crust takes part very largely in this redistribution or discharge, whichever it is called, the current passing in any part of that crust will depend upon two things only—the formation of the crust at that particular point, and the surface contact between the principal conductor contained in it and the conductor leading to the ground.

Take, for instance, a broad, deep river, such as the Thames or the Mersey; the resistance offered by the river to the discharging or redistributing current must be small, provided the contact made between it and, say, the end of a conductor leading to it is large. On the other hand, the resistance offered by a hard, impervious rock will be light, But, as is well known, if the contact with the river is very small, the resistance offered to the current may be high; while even in the case of a hard rock, if we could obtain a large enough surface contact, the resistance might be reduced to moderate dimensions.

But how does this affect the question of the lightning discharge? In the writer's opinion the question is affected by these matters, because in all cases of discharge or redistribution, it is along these paths that the current which carries out the redistribution must flow.

There is a difference of potential between one end of the cloud and one part of the earth, but there is also, by reason of that difference of potential, a further tension between the same part of the earth and neighbouring portions, and no matter how the result may come—either by sparking from the cloud to some object on the earth's surface, by sparking from cloud to cloud, by silent discharge between cloud and surrounding objects, or by the cloud moving on—whenever a redistribution does take place it necessitates currents passing between the parts of the earth, or the objects on it, that are at different potentials, and these currents must pass through the earth's crust, the objects on it, and through the surrounding atmosphere in accordance with the laws already stated.

Now examine the case of a lightning conductor attached to a high building or to a mill chimney. What position does it occupy with reference to the charged cloud overhead?

It is perhaps as well to explode the old idea that the conductor is able to attract all the charge to itself. The lightning-rod forms merely one of many paths open to the discharging or redistributing current. Each of the chimneys of the building, with their soot linings, forms another part. The stone or brickwork of which the building or chimney is composed forms other paths, mainly on account of the moisture held in them.

If the lightning conductor is able to protect the building to which it is attached, it will be because the additional path formed by it for the discharging current has reduced the E.M.F. available below the point at which it can do other mischief.

But if it is to do that, obviously it must be arranged to carry the largest possible current away. Obviously, also, the only way in which this can be accomplished is by making the conductor form a portion of a path of low resistance; and how is this to be done except by connecting it by means of a large surface contact with the mass of the best conductors to be found in the earth's crust where the conductor joints it—in other words, by making *good earth* as electrical engineers understand the term.

The lightning current will not mind ploughing up a few yards of earth when it reaches ground, but there is no reason that it should be allowed to do so if it can be avoided, as it can by making a good earth connection.

A *good earth* would, of course, mean, if available, the bed of a river, wide and deep, connection being made to the water by means of a large metal plate. But, it is replied, if good earth, as you call it, will do the trick, why are buildings struck where the conductors have good earth? Why is a poor sheep struck in the open, standing upon wet ground? Surely he is making good earth. What about side flashes also? Where does good earth come in there? The answer is, and it had better be faced at once, that unless the number of conductors is much multiplied, in the case of large buildings, each conductor making good earth, and, if possible, a separate earth, unless the bed of a large river is available, it is impossible to absolutely ensure protection from lightning. But while it is impossible to ensure absolute protection from lightning, just as it is impossible to ensure immunity from many other things, the one thing that will tend, and the only thing that will tend to protect from lightning is the multiplication before described, all the conductors being *well earthed*.

It is obvious, of course, that where good earth is obtainable fewer conductors are necessary than where it is not. The reason why this is the only plan available is that which has been already mentioned—viz., that the conductor only forms one path of many open to the discharging current, and that it only protects if it is able to reduce the E.M.F. present between the cloud, or the conductor when struck, and surrounding objects below danger point. In the case of a large square building, it might very possibly happen that portions of its roof would be at different potentials, from the very fact of the existence of a conductor on one side; and though one side might be efficiently protected by the conductor placed there, there might be a dangerous E.M.F. still existing after discharge between another part of the cloud and some other part of the building. The remedy is obviously, multiply conductors and *earth them all* separately. The same reasoning applies to side flashes. They are due to the existence of an E.M.F. between the conductor while carrying out its office of discharging or redistributing, and the object to which the flash passes, which the conductor has not been able to kill.

It should be noted, however, that side flashes cannot take place except to objects which form part of a circuit of such resistance that a current can pass through this path, including the air space over which the flash passes. Gas brackets and pipes are the most usual recipients of side flashes, the reason being that they, being in connection with the large mass of main pipes lying in the ground, forming good earth, affords such a path as has been described. The remedy is, as before, multiply the lightning conductors, and apply the high resistance method to the gas-pipes and other possible recipients. Place them as far from the path of discharge as you can.

The case of animals and trees being struck in the open field arises from the fact that there is no discharging path near, and therefore a dangerous E.M.F. is present, the actual path of the discharge being determined by special conditions in each case.

The remedy would be here, as in other cases, to fix a number of conductors about a field where animals grazed during thunder weather, always getting as good earth as possible. A similar plan would probably protect valuable plantations of forest trees.

In conclusion, the writer would point, in confirmation of his views, to the comparative immunity of towns from the effect of lightning discharges, and he attributes this immunity to the fact that so many paths are open for the discharge of the thundercloud. Most of them have a high resistance, and do not make good earth, but their infinite multiplication gives the same result, even to the *good earth*, in another form. Suppose, for instance, the resistance of the column of smoky hot air, soot-lined chimney, fire-grate, and foundation together amount to 1,000 ohms, a thousand such paths will bring the resistance to only one ohm; while in the case of a very large city, the combined resistance of all the paths open to the discharging current would be very small indeed.

The writer would also point to the fact that though lightning has frequently been seen in the workings of a mine, and has often pulled down colliery chimneys, and done damage at the pit bottom, no damage has ever been done by it in the mine itself, the coal, rails, etc., acting as conductors to distribute the charge, and the damage done at the pit bottom being due to the sudden break from a conductor of low resistance to one of high resistance, without good surface contact—without, in fact, a good connection to earth.

The writer has not touched upon the static side of the question, but it is obvious that most of the remarks given above apply equally, whether the matter be looked at from the electrostatic or electro-dynamic point of view. Each conductor, each body that will or does conduct, not only does so, but it dissipates a portion of the charge from the electrostatic capacity of the condenser or condensers, of which it forms a part; and this is surely an argument for getting the conducting surface to which the discharging current is conveyed as large as possible. That is getting *good earth*.

It should perhaps be noted that the office of *good* "earth" would be very well filled by the congregation together of a number of large masses of metal, in more or less good connection, electrically speaking, such as a large town built entirely of iron—a thing which may perhaps one day come to pass. Failing this, however, our next best substitute is the earth's crust, solely on account of its large proportions, and this is only available where we can get good connection to the principal conductor in it, the moisture that is always present.

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THE B.A. MEETING.

Electricians of all grades and of all opinions have never been wanting in praise of the good work done by the British Association on electrical measurements. Its resolutions have had a world-wide effect. All countries have accepted them, and have had little or nothing to say against the work. There is no doubt but that the B.A. committee was formed at an opportune moment and did yeoman service for the cause. Chaos gave place to order. Some of the younger spirits of the Association, seeing what great good arose from the committee on measurements, have an idea that a discussion on units—notation and nomenclature—may be of some service. This new departure in discussion between two sections puts us in mind of a musical ride by the Guards. It is very showy, very entertaining, but of no real value. We have attended several of these discussions, but do not remember that any tangible result was ever obtained. There is no doubt that some settled system of units is required, instead of every individual author propounding units and names for himself. There is, again, a good feature in the endeavour to perpetuate the name of a man renowned in science by giving his name to some common unit, but this system may be carried to excess. Are we so conceited as to imagine that Science is going to stand still after our day? It certainly seems so. What about the men of the future? We are acting as if our conclusions were infallible; whereas half a century hence may show them to have been as far from the truth as the conclusions of the Greeks in astronomy. Discuss units by all means; but not through a formal or informal meeting of sections, but by means of a well-organised committee.

CITY AND SOUTH LONDON RAILWAY.

" I hope that the future profits of the line will go on steadily increasing, and that it will not be so very long before I may have the pleasure of standing here and feeling that we have earned a substantial dividend. But that rests with the future, and I do not like to prophesy on these points." Thus the chairman of the City and South London Railway Company at the half-yearly meeting held on Tuesday last. Everything was going on very well. The Board could affirm that their system of electric locomotion would work, and could go even further, and say that it had worked satisfactorily. But—would it pay? Well, the future must answer that question. They hoped and believed it would. At present, however, the company have only just managed to pay the interest on their debentures, £4,137, and to carry forward a small balance of £555. And unless the weekly receipts, which we have published regularly in our City Notes, show some signs of expansion, it does not look as if a much better financial statement awaits the shareholders next winter. The Board are doing their best to fill up the trains during the middle of ie day. At first, as it will be remembered, a niform fare of 2d. all the way was charged. But was soon found that though this did well enough or the through traffic, which tested the capacity of he railway to its uttermost in the morning and vening, it rather interfered with the intermediate tation to station traffic. In order, therefore, to ill their trains during the middle of the day, he company introduced penny fares at certain stations and at stated times. The result was satisfactory, and the receipts at these stations increased some 50 per cent. The question of carrying this system of reduced fares still further is being carefully considered by the directors. Naturally they do not like giving up the uniform system, which is convenient and cheap to work; but the encouragement of a 50 per cent. rise will probably go a long way to helping the board to give up their pet idea. There are some pleasant features in the chairman's speech, however. It is satisfactory to be able to carry 2½ millions of people without an accident. True, this was qualified the other day by a fatal mishap in connection with one of the big lifts. But as the individual who met his death "acted in violation of the company's by-laws and in direct defiance of its officers," the chairman is fairly entitled to his expression of satisfaction; though, as we have pointed out in a recent issue, the company would do well to see to the closing of the doors of its lifts before they are set in motion. Then the working expenses are being cut down; the staff have been educated in their duties; the lighting of the trains has been improved; and fresh departures in the way of perfection are being considered The Board have had to give up their Islington extension project, a fact which will afford satisfaction to those shareholders who want to see the old line pay before a new one is built.

LIGHTNING AND CONDUCTORS.

It is not always wise to prohibit publicity to opinions not in accordance with those held by the majority. Mr. S. F. Walker throws down the gauntlet to Dr. Lodge, but Mr. Walker may rest assured that Dr. Lodge will not enter into any controversy upon the subject. Dr. Lodge has promulgated heterodox views in regard to protection from lightning, and has, we believe, taken the majority with him in most of the opinions he has advanced. There are points, however, in which Dr. Lodge is just as likely to be wrong as he is to be right. So long as Mr. Walker holds to the view that lightning, or any other form of electricity, acts in accordance with Ohm's law, and traverses the circuit of least resistance, he is upon pretty safe ground, and we should hesitate to believe Dr. Lodge objects to this, as Mr. Walker seems to think. There is absolutely no reason to be advanced why lightning should act in any other direction than the circuit of least resistance—though it would be impossible in the present state of our knowledge to trace the circuit. Much of what Dr. Lodge has advanced points to the old view that electricity is an entity, but no doubt theories are about as near to the actual facts as were the theories of our ancestors in regard to heat to those of the present day. However, our readers will judge for themselves how far Mr. Walker has weakened Dr. Lodge's contention. After all, what is good earth? Is it one link in the circuit? What are the varying conditions which at one time makes a part of the earth's surface a good conductor at another time not so good? Is moisture the sole ingredient in the "good" or "bad"? We always took it to be admitted that pure water was not so good a conductor as those who go in for moist earth would have us believe. Is good earth, then, determined by what the water holds in suspension? If so, what constitutes the best earth, and how would Mr. Walker obtain it?

UNDERGROUND LIGHTING MAINS IN PARIS.*

BY E. DIEUDONNÉ.

In accordance with the conditions laid down by the specification which regulates this matter, all electric conductors are underground. The method of laying them differs according to the companies to whom the concession for so doing is granted. One principle common to all is that they must be laid in trenches under the footways at a suitable distance from the houses, and that where the roadways are crossed vaulted subways large enough to admit men must be provided. The Place Clichy sector, however, is not provided with these latter. As is known, the area of the city has been split up into a certain number of zones, dividing the central portions or arteries, and extending to the circumference bounded by the city wall. These geographical divisions, called sectors from the distant resemblance their configuration bears to the geometrical figure of this name, have been handed over under the conditions and clauses of the specification to different companies under concessions. We shall only deal with those (in alphabetical order) which have carried out work (the others will appear in due time)—viz.:

(a) The Compagnie Parisienne d'air comprimé et d'electricité.
(b) The Société d'éclairage et de force par l'electricité.
(c) The Société Edison.
(d) The Société du Secteur de la place Clichy.

(A) Parallel with these four groups is the city station at the central markets.

The special precautions taken in the different methods of running mains are generally adjusted according to the method of distribution adopted. We will make a few digressions into this particular subject to determine its general characteristics, without unduly putting aside the subject of this article.

Compagnie d'air comprimé et d'electricité.

Two air compressing stations, one in the Rue Saint-Fargeau, the other on the Quai de la Gare, supply a network of conduits which convey the agency for producing the motive power needed for working the sector, to three central stations situated at the Retiro, at the Bourse de Commerce, and in the Rue Dieu. From each of these stations a high-pressure circuit leads to battery sub-stations. The Retiro charging circuit feeds the following sub-stations—viz.: (1) 416, Rue Saint-Honoré; (2) Rue de L'Echelle; (3) 11, Rue Gaillon; (4) 2, Rue Saint-Augustin; (5) 21, Rue de la Paix; (6) 45, Rue Cambon. The Bourse circuit feeds: (1) 54, Rue Etienne-Marcel; (2) 5, Rue Feydeau; (3) the Theatre of Varieties; (4) 108, Rue Richelieu; (5) the Passage du Saumon; (6) 36, Boulevard Sebastopol; (7) 8, Rue Pernelle; (8) Bazar de de Ville; (9) 31, Rue des Bourdonnais. These two circuits have double cables, and each constitute two parallel circuits, including or neglecting the batteries of certain stations in which these are cut out by a switch. The object of this arrangement is to balance the different sub stations during normal periods, and to allow of provisional grouping in case of accidents.

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* From *L'Electricien.*

The third charging circuit fed from the Rue Dieu has a single cable, and includes the following sub-stations—viz., (1) 83, Rue Turbigo; (2) 9, Rue Bourg l'Abbé; (3) Passage Lemoine; (4) 4, Rue d'Hauteville; (5) 13, Boulevard Voltaire.

Finally, there is a fourth station working by means of steam in the Boulevard Richard-Lenoir, having two charging circuits, one of which feeds sub-stations at 6, Rue Malher and 20, Rue de la Verrerie, and the other, sub-stations at 70, Boulevard Beaumarchais and 6, Rue de Franche-Comté. These four circuits are completely separate and autonomous; at the same time there are localities where auxiliary cables, called dead cables, afford connections between neighbouring circuits, which in regular working are cut out, but which, in case of accident on any of these circuits, enable it to be supplied by one of the others. The charging current is maintained constant at 200 amperes; the pressure varies directly as the number of accumulators under charge, and may rise to 2,400 volts. There are two batteries of accumulators in each sub-station in order that the permanence of the discharge on the secondary circuit supplying customers may be assured.

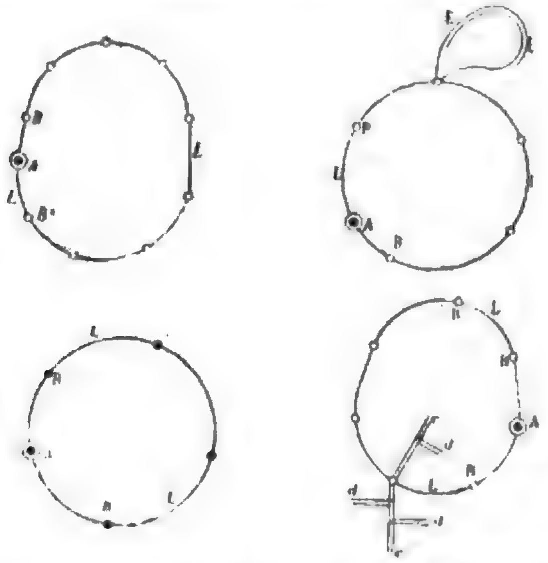


Fig. 1.—A A A A. Charging stations. B B B. Sub-stations in series. *c c*. Radiating circuit. *d d*. Customers' leads. E E. Lamp circuits. L L L. Charging circuits.

The secondary circuit is laid in two different ways. In the central parts of the city it consists of circuits radiating round the sub-station, about 250 metres in length, on which are placed special installations; the excess charge in the houses of the customers nearest to the station is absorbed by rheostats on their premises. All the sub-stations of the Retiro circuit, of the Bourse de Commerce, and of the Turbigo, Rue Bourg l'Abbé, and Passage Lemoine circuits, are arranged on this principle. All the other stations near the peripheral districts feed loop circuits, the two conductors, both positive and negative, returning under the footway on the opposite side of the street, so as to serve both sides. The conductors are of bare wire, placed in troughs and mounted on porcelain insulators. The charging cables, as well as those of the radiating circuits, are insulated by a coating of indiarubber, covered with a protecting envelope of lead and hemp. The first are very highly insulated; their cost reaching to 20,000f. per kilometre; the second mentioned, which are not so costly, work out to 16,000f. per kilometre.

The distributing arrangements adopted, and those which proceed therefrom, are graphically summed up in Fig. 1. The general idea has been worked out from the suggestions of M. Solignac. The mention of his name reminds us that we have to complete the exposition of the economy of the sector. It was a question of working with alternate-current transformers side by side with accumulators. How was this done? By means of an apparatus called "the undulator, devised by M. Solignac, the object of which was to employ transformers on continuous current circuits. We saw this apparatus working at the Centenary Exhibition of 1889. It fed Jablochkoff candles by Gaulard and Gibbs transformers, with a current obtained from a continuous-current dynamo. If our memory does not deceive us, the ruling principle of this device consists in placing two transformers in the sub-stations, putting an "undulator" in shunt with each transformer, and in the transformer branch a current reverser.

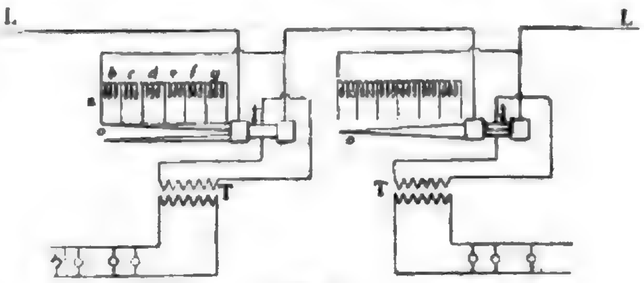


Fig. 2.

The "undulator" is a kind of rotating commutator, which places in circuit with the first transformer a series of resistances so arranged that at the moment of the short circuit, indicated at *a* in Fig. 2, no current passes in the corresponding transformer, whilst the whole current is on in the second transformer and in the line.

As the "undulator" rotates, so the resistances *b*, *c*, *d*, *e*, *f*, *g*, are inserted in shunt with the transformer; the current increases in the latter as shown by the curve *a b*, Fig. 3, up to the point of complete opening of the circuit, where it receives all the current, that is at the point *b*. Continued working of the apparatus again successively cuts out the

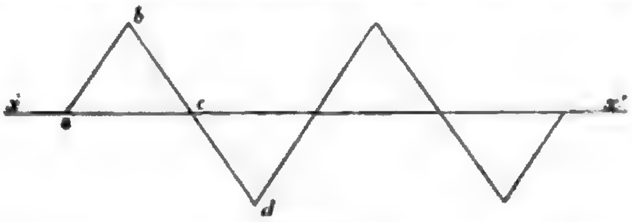


Fig. 3.

resistances *g*, *f*, *e*, *d*, *c*, *b*, up to the moment when the transformer is short circuited. This point is utilised to reverse the poles of the transformer, and, as a consequence, a new curve, *c d*, is described below the axis, $x\ x'$. The undulator is always in duplicate, so that when one transformer is short circuited the other is not, the object being to equalise the work on the machine.

(To be continued.)

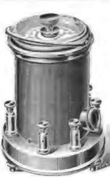
A NON-INDUCTIVE WATTMETER.

Great difficulty has always been felt in measuring power with alternate currents. The ordinary wattmeter, though accurate with direct currents when a correction is made for the power taken by the instrument itself, is of little value for use with alternate currents, as the time-constant of the fine wire circuit is appreciable. If the pressure and current are in step, as is the case when an alternate pressure is applied to a resistance, such a wattmeter reads too low. If a pressure is applied to an inductive circuit, on the other hand, the reading may be much too high.

Messrs. Swinburne and Co. have brought out a wattmeter specially designed to avoid these errors. The moving coil contains but few turns, and these are wound on a light mica former. The coil is held by top and bottom stretched wires. External resistances are supplied, wound with the alternate layers right and left handed. The time-constant of the fine wire circuit is thus made sensibly equal to zero. Readings are taken by means of a torsion head in the usual way, but for measurements of minute powers, such as hundredths of a watt, a mirror is used. These wattmeters are wound to suit any range from 3,000 volts, and from 25 amperes downwards.

They are stated by the makers to read accurately on non ıductive resistances, and on inductive circuits in which the roduct of the pressure and current is 50 times the real ower.

The wattmeter has the advantage over electrometer ıethods, that it does not involve the very serious troubles ver resistances. Mr. Swinburne recently described an lectrometer which reads power directly, which, though it oes the work of the three voltmeters discussed by Messrs. ıyrton, Sumpner, and Swinburne soon after, unfortunately requires resistances. Dr. Fleming has enormously improved the three-instrument method by substituting amperemeters, and we thus have unimpeachable means of verifying the wattmeter. If this wattmeter does what the makers claim for it, it will be exceedingly valuable to alternating-current engineers.



EXPERIMENTS WITH ALTERNATE CURRENTS OF VERY HIGH FREQUENCY AND THEIR APPLICATION TO METHODS OF ARTIFICIAL ILLUMINATION.*

BY NIKOLA TESLA.

(Continued from page 131.)

With these rapidly alternating potentials there is, however, no necessity of enclosing two blocks in a globe, but a single block, as in Fig. 20, or filament, Fig. 23, may be used. The potential in this case must of course be higher, but it is easily obtainable, and besides it is not necessarily dangerous.

The facility with which the button or filament in such a lamp is brought to incandescence, other things being equal, depends on the size of the globe. If a perfect vacuum could be obtained, the size of the globe would not be of importance, for then the heating would be wholly due to the surging of the charges, and all the energy would be given off to the surroundings by radiation. But this can never occur in practice. There is always some gas left in the globe, and although the exhaustion may be carried to the highest degree, still the space inside of the bulb must be considered as conducting when such high potentials are used, and I assume that in estimating the energy that may be given off from the filament to the surroundings we may consider the inside surface of the bulb as one coating of a condenser, the air and other objects surrounding the bulb forming the other coating. When the alternations are very low there is no doubt that a considerable portion of the energy is given off by the electrification of the surrounding air.

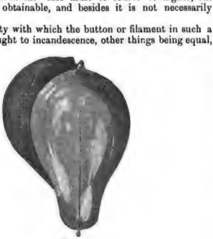


FIG. 23.

In order to study this subject better, I carried on some experiments with excessively high potentials and low frequencies. I then observed that when the hand is approached to the bulb—the filament being connected with one terminal of the coil—a powerful vibration is felt, being due to the attraction and repulsion of the molecules of the air which are electrified by induction through the glass. In some cases where the action is very intense I have been able to hear a sound, which must be due to the same cause.

When the alternations are low, one is apt to get an excessively powerful shock from the bulb. In general, when one attaches bulbs or objects of some size to the terminals of the coil, one should look out for the rise of potential, for it may happen that by merely connecting a bulb or plate to the terminal, the potential may rise to many times its original value. When lamps are attached to the terminals, as illustrated in Fig. 24, then the capacity of the bulbs should be such as to give the maximum rise of potential under the existing conditions. In this manner one may obtain the required potential with fewer turns of wire.

The life of such lamps as described above depends, of course, largely on the degree of exhaustion, but to some extent also on the shape of the block of refractory material. Theoretically it would seem that a small sphere of carbon enclosed in a sphere of glass would not suffer deterioration from molecular bombardment, for, the matter in the globe being radiant, the molecules would move in straight lines, and would seldom strike the sphere obliquely. An interesting thought in connection with such a lamp is, that in it "electricity" and electrical energy apparently must move in the same lines.

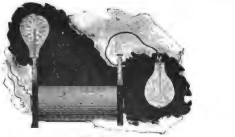


FIG. 24.

The use of alternating currents of very high frequency makes it possible to transfer, by electrostatic or electromagnetic induction through the glass of a lamp, sufficient energy to keep a filament at incandescence and so do away with the leading-in wires. Such lamps have been proposed, but for want of proper apparatus they have not been successfully operated. Many forms of lamps on this principle, with continuous and broken filaments, have been constructed by me and experimented upon. When using a secondary enclosed within the lamp, a condenser is advantageously combined with the secondary. When the transference is effected by electrostatic induction, the potentials used are, of course, very high with frequencies obtainable from a machine. For instance, with a condenser surface of 40 centimetres square, which is not impracticably large, and with glass of good quality 1 mm. thick, using currents alternating 20,000 times a second, the potential required is approximately 9,000 volts. This may seem large, but since each lamp may be included in the secondary of a transformer of very small dimensions, it would not be inconvenient, and, moreover, it would not produce fatal injury. The transformers would all be preferably in series. The regulation would offer no difficulties, as with currents of such frequencies it is very easy to maintain a constant current.

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* Lecture delivered before the American Institute of Electrical Engineers at Columbia College, New York, May 20.

In the accompanying engravings some of the types of lamps of this kind are shown. Fig. 25 is such a lamp with a broken filament, and Fig. 26A and Fig. 26B one with a single outside and inside coating and a single filament. I have also made lamps with two outside and inside coatings, and a continuous loop connecting the latter. Such lamps have been operated by me with current impulses of the enormous frequencies obtainable by the disruptive discharge of condensers.

The disruptive discharge of a condenser is especially suited for operating such lamps—with no outward electrical connections—by means of electromagnetic induction, the electromagnetic inductive effects being excessively high; and I have been able to produce the desired incandescence with only a few short turns of wire. Incandescence may also be produced in this manner in a simple closed filament.

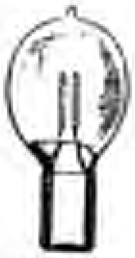

Fig. 25.

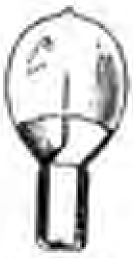

Fig. 26b.

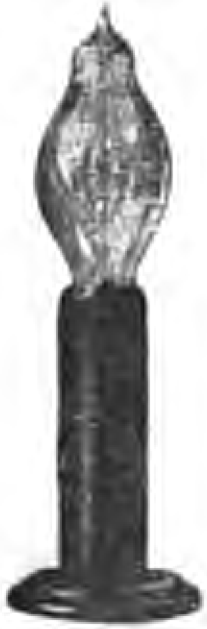

Fig. 26a.

Leaving, now, out of consideration the practicability of such lamps, I would only say that they possess a beautiful and desirable feature—namely, that they can be rendered at will more or less brilliant, simply by altering the relative position of the outside and inside condenser coatings, or inducing and induced circuits.

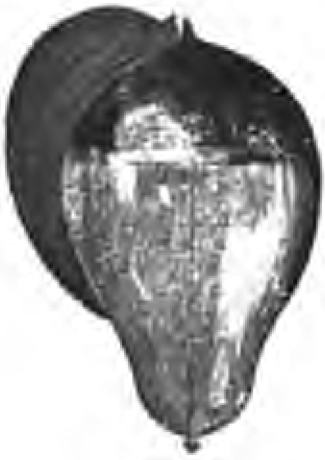

Fig. 27.

When a lamp is lighted by connecting it to one terminal only of the source, this may be facilitated by providing the globe with an outside condenser coating, which serves at the same time as a reflector, and connecting this to an insulated body of some size. Lamps of this kind are illustrated in Fig. 27 and Fig. 28. Fig. 29 shows the plan of connections. The brilliancy of the lamp may in this case be regulated within wide limits by varying the size of the insulated metal plate to which the coating is connected.

It is likewise practicable to light with one leading wire lamps, such as illustrated in Fig. 21 and Fig. 22, by connecting one terminal of the lamp to one terminal of the source, and the other to an insulated body of the required size. In all cases the insulated body serves to give off the energy into the surrounding space, and is equivalent to a return wire. Obviously, in the two last-named cases, instead of connecting the wires to an insulated body, connections may be made to the ground.

The experiments which will prove most suggestive and of most interest to the investigator are propably those performed with exhausted tubes. As might be anticipated, a source of such rapidly alternating potentials is capable of exciting the tubes at a considerable distance, and the light effects produced are remarkable.

During my investigations in this line I endeavoured to excite tubes, devoid of any electrodes, by electromagnetic induction, making the tube the secondary of the induction device, and passing through the primary the discharges of a Leyden jar. These tubes were made of many shapes, and I was able to obtain luminous effects which I then thought were due wholly to electromagnetic induction. But on carefully investigating the phenomena I found that the effects produced were more of an electrostatic nature. It may be attributed to this circumstance that this mode of exciting tubes is very wasteful—namely, the primary circuit being closed, the potential, and consequently the electrostatic inductive effect is much diminished.

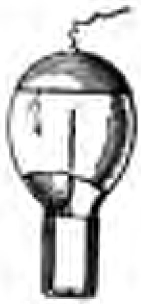

Fig. 28.

When an induction coil, operated as above described, is used, there is no doubt that the tubes are excited by electrostatic induction, and that electromagnetic induction has little, if anything, to do with the phenomena.

This is evident from many experiments. For instance, if a tube be taken in one hand, the observer being near the coil, it is brilliantly lighted and remains so in no matter what position it is held relatively to the observer's body Were the action electromagnetic, the tube could not be lighted when the observer's body is interposed between it and the coil, or at least its luminosity should be considerably diminished. When the tube is held exactly over the centre of the coil—the latter being wound in sections and the primary placed symmetrically to the secondary—it may remain completely dark, whereas it is rendered intensely luminous by moving it slightly to the right or left from the centre of the coil. It does not light because in the middle both halves of the coil neutralise each other, and the electric potential is zero. If the action were electromagnetic, the tube should light best in the plane through the centre of the coil, since the electromagnetic effect there should be a maximum. When an arc is established between the terminals, the tubes and lamps in the vicinity of the coil go out, but light up again when the arc is broken, on account of the rise of potential. Yet the electromagnetic effect should be practically the same in both cases.

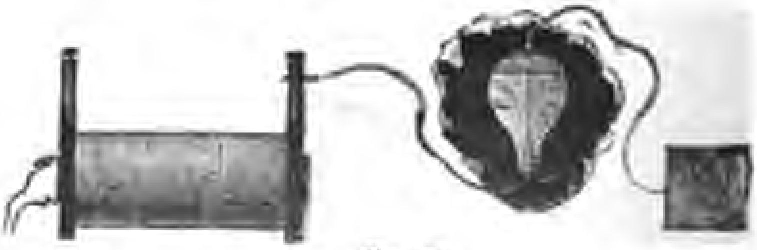

Fig. 29.

By placing a tube at some distance from the coil, and nearer to one terminal—preferably at a point on the axis of the coil—one may light it by touching the remote terminal with an insulated body of some size or with the hand, thereby raising the potential at that terminal nearer to the tube. If the tube is shifted nearer to the coil so that it is lighted by the action of the nearer terminal, it may be made to go out by holding, on an insulated support, the end of a wire connected to the remote terminal, in the vicinity of the nearer terminal, by this means counteracting the action of the latter upon the tube. These effects are evidently electrostatic. Likewise, when a tube is placed at a considerable distance from the coil, the observer may, standing upon an insulated support, between coil and tube, light the latter by approaching the hand to it; or he may even render it luminous by simply stepping between it and the coil. This would be impossible with electromagnetic induction, for the body of the observer would act as a screen.

When the coil is energised by excessively weak currents, the experimenter may, by touching one terminal of the coil with the tube, extinguish the latter, and may again light it by bringing it out of contact with the terminal and allowing a small arc to form. This is clearly due to the respective lowering and raising of the potential at that terminal In the above experiment, when the tube is lighted through a small arc, it may go out when the arc is broken, because the electrostatic inductive effect alone is too weak, though the potential may be much higher; but when the arc is established, the electrification of the end of the tube is much greater, and it consequently lights.

If a tube is lighted by holding it near to the coil, and in the hand which is remote, by grasping the tube anywhere with the other hand, the part between the hands is rendered dark, and the singular effect of wiping out the light of the tube may be produced by passing the hand quickly along the tube and at the same time withdrawing it gently from the coil, judging properly the distance so that the tube remains dark afterwards.

If the primary coil is placed sidewise as in Fig. 17B for instance, and an exhausted tube be introduced from the other side in the hollow space, the tube is lighted most intensely because of the increased condenser action, and in this position the striæ are most sharply defined. In all these experiments described, and in many others, the action is clearly electrostatic.

The effects of screening also indicate the electrostatic nature of the phenomena and show something of the nature of electrification through the air. For instance, if a tube be placed in the direction of the axis of the coil, and an insulated metal plate be interposed, the tube will generally increase in brilliancy, or if it be too far from the coil to light, it may even be rendered luminous by interposing an insulated metal plate. The magnitude of the effects depends to some extent on the size of the plate. But if the metal plate be connected by a wire to the ground, its interposition will always make the tube go out, even if it be very near the coil. In general, the interposition of a body between the coil and tube, increases or diminishes the brilliancy of the tube, or its facility to light up, according to whether it increases or diminishes the electrification. When experimenting with an insulated plate, the plate should not be taken too large, else it will generally produce a weakening effect by reason of its great facility for giving off energy to the surroundings.

If a tube be lighted at some distance from the coil, and a plate of hard rubber or other insulating substance be interposed, the tube may be made to go out. The interposition of the dielectric in this case only slightly increases the inductive effect, but diminishes considerably the electrification through the air.

In all the cases, then, when we excite luminosity in exhausted tubes by means of such a coil, the effect is due to the rapidly alternating electrostatic potential; and, furthermore, it must be attributed to the harmonic alternation produced directly by the machine, and not to any superimposed vibration which might be thought to exist. Such superimposed vibrations are impossible when we work with an alternate-current machine. If a spring be gradually tightened and released, it does not perform independent vibrations; for this a sudden release is necessary. So with the alternate currents from a dynamo machine: the medium is harmonically strained and released, this giving rise to only one kind of waves; a sudden contact or break, or a sudden giving way of the dielectric, as in the disruptive discharge of a Leyden jar, are essential for the production of superimposed waves.

In all the last described experiments, tubes devoid of any electrodes may be used, and there is no difficulty in producing by their means sufficient light to read by. The light effect is, however, considerably increased by the use of phosphorescent bodies such as yttria, uranium, glass, etc. A difficulty will be found when the phosphorescent material is used, for with these powerful effects it is carried gradually away, and it is preferable to use material in the form of a solid.

Instead of depending on induction at a distance to light the tube, the same may be provided with an external—and, if desired, also with an internal—condenser coating, and it may then be suspended anywhere in the room from a conductor connected to one terminal of the coil, and in this manner a soft illumination may be provided.

(To be continued.)

NOTES ON ELECTRICAL WORK IN MINES.*

BY ALBION T. SNELL, ASSOC.M.I.C.E., M.I.E.E.

Perhaps no branch of engineering has received more attention of late than the application of electricity to the ordinary purposes of mining. At home, on the Continent, and in America, electrical energy has been applied to this work, and in the majority of instances with success. The general theory underlying the application of this power has been discussed again and again, and numerous illustrations have from time to time been given, so that in reopening the matter before the South Wales Institute of Engineers, I feel some difficulty in selecting the precise lines for my paper. The theoretical side of the question is not a suitable subject for discussion here, and from the practical point of view, plants illustrative of pumping, hauling, coal cutting, etc., have been shown so often as to lessen the immediate interest. My object in reading this paper, then, is simply to open a discussion to induce members to give their various experiences of electric work, so that by a comparison of such data we may be enabled to form an adequate idea of the work now being performed in collieries by this agency, and I hope that there will ensue a lengthy discussion which will materially add to the practical knowledge now extant on this important department of engineering.

With this view I purpose, even at the risk of describing what has already been published elsewhere, to briefly refer to one or two of the more important plants now running in Great Britain, and especially a pumping plant at Messrs. Crawshay Brothers' Newbridge Rhondda Colliery. These plants have been erected under my own superintendence and I have selected them because they are applicable for lighting as well as for power, and are so installed that the energy may be divided into separate units at different parts of the circuit, just as several engines can be driven off a compressed air system.

In February, 1890, the question of "The Electrical Distribution of Energy over Extended Areas in Mines" was discussed before the Federated Institute of Mining Engineers, and I then proposed the use of over-compounded dynamos for this purpose. When the matter was also discussed at the Newcastle meeting in 1891, I was able to state that several installations designed on these lines had been working successfully for some time. One of these was the Newbridge Rhondda Colliery pumping plant, and by the courtesy of Mr. Abraham, the manager, I am able to bring the following details before you. This plant is typical of the system; it is successful here, and there is no reason to prevent it being equally successful under similar conditions in other pits. The problem was to drive two pumps off the same set of mains. The pumps were 700 yards apart, and it was required to make each independent, so as to be stopped or started without affecting the speed of the other. It was also imperative that the electric light should be used at the pumping stations, at the pit bank and pit bottom; and, further, there was to be only one dynamo. These conditions assumed that the pressure would be practically constant throughout the circuit. In practice, it is impossible to secure an absolutely constant pressure all over the system, owing to the resistance of the mains themselves; but by over-compounding the dynamo, so as to give a constant pressure at a point near the centre of the system, it is possible to approximate very closely to the required conditions. How well the case has been met is apparent when I mention that both the pumps can be switched off without appreciably raising the voltage of the lamps. The dynamo is one of our Sh. D. C. 12/16 type, and running at 800 revolutions per minute gives a pressure of 300 volts and 60 amperes. Each of the motors gives 7 b.h.p., and runs at 800 revolutions per minute. The lamps are coupled in series of three. The pumps are three-throw rams, 4in. in diameter by 9in. stroke. Mr. Abraham tells me the plant has been perfectly successful from the first, and he hopes to extend the use of electricity at an early date.

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* Paper taken as read at the annual meeting of the South Wales Institute of Engineers, July 27, 1891.

Another interesting application of electricity which is likely to be of use in certain cases is a new system of haulage patented by Messrs. G. B. Walker, of Wharncliffe Silkstone, and Immisch, of the G. E. P. and T. Company. In this system the loco does not depend for grip on its own weight, but gets a direct pull on a cable lying between the rails, parallel to the road, and fixed at either end. This cable passes over a sprocket wheel on the loco or trolley, and is driven through suitable gearing by an electric motor. The motor is supplied with energy from a bare copper wire arranged on the roof or the side of the road. It is needless to say that such a trolley is only applicable to roads free from gas. The chief advantage of the system lies in the light weight of the trolley in proportion to the heavy tractive effort it can exert. It will be principally used as an auxiliary power on short steep lengths of otherwise fairly level roads, where horses are generally used, and will be found in many cases to be a great saving in horseflesh. A loco or trolley of this type has been running at Wharncliffe Silkstone Collieries for nearly 12 months on a brow 500 yards long, with a grade averaging 1 in 9. It raises loads of about five tons at a speed of three miles per hour. Formerly, 12 horses were required for the work, and even with this number it was so severe that it was not deemed advisable to keep the same animals at it for more than six months at a time. Mr. Allison, my assistant, who erected the line, gives me the following figures, roughly measured, which will be interesting from the electrical point of view:

Rolling load	5 corves	4 tons.
Average speed	2·65 miles per hour.	
Average grade	1 in $9\frac{1}{3}$	
Grade 1 in 12	Amperes, 45	Volts, 180.
Grade 1 in 11	Amperes, 50	Volts, 190.
Grade 1 in 10	Amperes, 55	Volts, 195.
Grade 1 in 9	Amperes, 65	Volts, 200.
Grade 1 in 8	Amperes, 70	Volts, 205.

Since the above figures were taken, a larger dynamo has been installed, and the loco will now do more work.

The loco trolley is unnecessarily heavy for the particular work, and was adapted for existing material; considerable improvements can be made in the design in future. The motor is rated at 10 brake horse-power.

Another interesting application of the compound parallel system is the installation at Andrew's House Pit, Durham, By the courtesy of Mr. Cuthbert Berkley I am able to give the following details: The plant comprises a dynamo, three motors, cables, and three dip pumps. The pumps are respectively 1,500, 1,800, and 2,000 yards in bye; the one nearest the shaft is driven by a 4-h.p. motor, the others each work by motors of 2-h.p. The dynamo gives 250 volts and 40 amperes. The total capacity of the plant is thus small, but it is interesting on account of the distance between the pumps and the length of the cable. A few lamps are run at each of the pump stations and also in the engine-house. The dynamo is arranged to compound for constant potential at about 1,500 yards in bye. But owing to the length of cable the pressure is not maintained so uniformly as at Newbridge Rhondda installation. Each of these motors has replaced a crank which required 12 horses to keep it running through the 24 hours. The plant has now been at work for nearly two years. I may mention in passing that a wire rope is used for the return, and no difficulty has been experienced from this; but if the pressure were higher, or the work larger, I should advise an insulated return.

In Bohemia, my company erected last year two plants of some importance in the history of mining in that district, they being the first application of electricity to mining work there. The first is at the Standard Tin Company's St. Mauritius Mine. The dynamo is placed below ground and is driven by a turbine, the water being led down a shaft by suitable pipes. The motor is arranged to work a pair of lift pumps with spears 40 metres long, and also to wind ore through the same vertical distance. When the installation was first made the lower levels were drowned out and the electric plant had to pump them dry before work could be resumed. This was successfuly accomplished in a shorter time than the engineers expected, and ore is now being regularly raised by the plant. The power of the motor is about 20 horse. The second instance is at Eger, at one of the brown coal mines; here the main ventilation is produced by a fan driven by electricity, and it is, I believe, the only mine where this is the case. The dynamo is driven by a turbine about half a mile away from the fan house, and the current is carried by bare wires mounted on poles with fluid insulators. The power of the motor is approximately 25 horse. The fan has now been running for about 12 months, and the manager reports that it is working perfectly satisfactorily.

We are now building a very interesting plant which illustrates the conversion of water power into electrical energy and its utilisation for light and power. One thousand yards from the Greenside Lead Mines, near Ullswater, there is a waterfall of upwards of 100 h.p. A turbine running at 1,000 revolutions per minute is coupled by a belt to one of our 100 e.h.p. four-pole transmission dynamos, wound in compound to give 625 volts and about 900 amperes. The energy is transmitted by a bare cable ($^{19}/_{15}$ S.W.G.) carried on poles to the mine mouth, and there lead-covered cables are used to convey the electricity to the various motors. These will at once run a winding plant of 10 b.h p., a pumping plant of 10 b.h.p., and another winding plant of 20 b.h p. is under consideration. Electric light will be used at different points of the line, and other motors will soon be installed for various purposes. Other examples might be given, but the preceding cases are fairly representative of the work now being done.

Every system of transmitting energy must necessarily entail certain risks peculiar to itself; therefore it is not surprising that we find such difficulties in connection with the use of electricity in mines. There is no doubt that the limits of these difficulties are very imperfectly understood by many mining engineers, and a few remarks on the subject may not be uninteresting. There are two distinct difficulties to contend with which may or may not be dangerous. The first is the risk from shocks. These may be received from any part of the circuit, if the installation be faulty, and under any circumstances from the brushes, commutator, and terminals of the dynamo and motors. The danger to be apprehended from electricity on this account depends primarily on the pressure of the circuit. Opinions are very much divided as to the number of volts necessary to cause death; but as, owing to difficulties of installation, the pressure in mines is usually limited to 500 volts or thereabouts, there is no fear of a fatal accident under any ordinary conditions. I have installed many plants of about this pressure, and have never heard of a single injury occurring to either the attendants or the miners, although shocks have necessarily been frequent. At St. John's Colliery, Normanton, we have been working for rather more than three years with a maximum pressure of 700 volts, without a single accident happening from this cause; and further, no casualty from electrical shock in any other mine in England has to my knowledge been heard of; consequently, I venture to think that this danger is practically negligible. The second difficulty which confronts us is the risk from fire, which may occur in two ways: by sparking at the commutator gas may be fired; or through a faulty connection or a bad leak, some part of the circuit may become heated and may set fire to timber. These dangers have frequently been discussed, but as a matter of fact no serious accident has occurred from the use of electricity, and should ordinary precautions be taken, and the plant be supplied and erected by a responsible firm, the chance of trouble on this score is extremely slight. Let us first look at the risks that belong to the cables themselves. It has been rightly surmised that in the event of a heavy fall of the roof breaking them, there may be a spark if ordinary single cables are used, but this danger may be minimised by using concentric cables; for if such a cable be broken by a fall, the mains will be short-circuited and the cut-out on the surface will fuse, thus cutting off the supply of electricity. In most cases, however, the cable is torn from its supports and simply buried beneath the stones, the strength of the conductor being greater than that of the supports. I have known several cases of this sort and the cables continued in use until the fall was removed, after which, being little the worse, they were re-erected. Even assuming that the cables should break, it by no means follows that the spark, if any, would be intense enough to fire gas, nor that gas would be there in sufficient quantities to be dangerous. I take it that risks of this kind are about on a par with the possibilities of a safety lamp exploding gas through a fracture of the glass which is liable to happen at any time by an accident. In fact, on the whole, I should think this danger is far greater than that from electric cables. But we are accustomed to the breakage of safety lamps, and not, as yet, to electrical work; and this is the chief point of difference.

The sparking at the brushes and commutator introduces a question of a different character altogether. Although in theory a well designed motor with commutator and brushes in good order is sparkless, certainly so far as not to fire gas, yet in practice, owing to wear and tear and possibly want of attention, all motors may at times spark badly. Then arises the question, will those sparks ignite gas? In 1888, when speaking on this subject before the Midland Mining Institute, I gave it as my opinion that the sparks at the brushes of a motor would not readily fire gas on account of their low temperature. This low temperature is due to the large mass of metal in contact with them. To make this point clear I made the following experiment: In a wooden box about 6ft. long with an internal cross section of a square foot, I put a small motor and a gas gauge; a glass window was arranged in the centre of the box so that the gauge could be read and the sparking noted. One end of the box was closed and the other fitted with a hinged door. Ordinary coal gas was then admitted at the closed end, and the motor started. The mixture of air and gas in the box was varied through the most explosive ranges and the motor ran for half-an-hour without firing the gas, although the brushes were sparking more than normally. These were then shifted so as to cause excessive sparking, thus heating both brushes and commutator, the heat at the points of the former being so great that oxide of copper was formed and deposited on them in a white film. At this point the gas exploded. Marsh gas and air explode at about 1,000deg. C. (1,832deg. F.) according to the mixture. It would appear to follow that although under normal conditions there would be little danger of a motor igniting gas, yet, if by any means the brushes and commutator became heated beyond a certain intermediate point, this danger would arise; and if motors are to be used in fiery mines it will be necessary to protect them.

Two ways of doing this suggest themselves. The one is to enclose the entire armature and commutator in a dust-tight metal box sufficiently strong to resist the force of the explosion of possible gas within it; and the other is to box in the commutator and brushes only. The former method has the advantage of also guarding against sparks caused by a possible short circuit on the armature. The second method does not protect the armature winding at all, but it reduces to a minimum the volume of gas which may be exploded by sparks. Both methods are good in their way, and, by proper attention to details, I believe that with either the risks will be comparatively slight. Of course, the best protection is ample ventilation, for if the faces are swept with plenty of fresh air, and the roof properly packed and looked after, there can be no danger from the cause in question. The protection of the motor should only be expected to act as a safeguard against "blowers," because under ordinary mining regulations men would not be allowed to work in a fiery atmosphere. If the motor be fixed at a pump or hauling engine, the difficulties are materially lessened, for the air would not be foul in such places, and if the "blower" worked against the main air-way there would be ample time for the men to switch off the motor before withdrawing, or it could be stopped from the surface.

THE ELECTRIC TRANSMISSION OF POWER.*

BY GISBERT KAPP.

Lecture III.

(*Concluded from page 138.*)

We must imagine this magnet alternately shrinking into nothing, and growing larger and stronger; also reversing its polarity each time that it passes through its zero condition. In the apparatus shown by Fig. 9, therefore, rotation of a real magnet on the left produces merely an oscillating magnetic field on the right. As you know, a magnetic field may be represented graphically, in direction and magnitude, by a straight line; and in this particular case the line so representing the oscillating field is the projection of the radius, O n, on the vertical M_1 M_1, if the length of the radius, O n, represents the strength of the field at maximum current. At the moment to which our diagram refers, our collapsible magnet will, therefore, have grown to the strength represented by the length, s_1 n_1; and, if there were no lag, the real revolving magnet would at that moment occupy the position S N. As there must be some loss in the transmission, I have shown N at a larger radius than n. If there is lag, then n and N will not lie on the same radius, but n will occupy, say, the position n', and the strength of the oscillating field will be n_1'. s_1'. The practical effect of lag is this, that the revolving magnet will have passed the vertical position shown in the diagram by the time the current has reached its maximum; and I can, therefore, eliminate the lag from the graphic diagram, by assuming that the revolving magnet has been shifted back through an angle equal to the angle of lag in this diagram, but left in its true position in the diagram representing the apparatus itself. In Fig. 9, the coils on the ring on the right hand are placed on the horizontal diameter. If, as in Fig. 10, I place them on the vertical diameter, the resulting oscillating field will be horizontal—namely, on the line M_2 M_2; and the projection of n on the vertical must be taken over to the horizontal, as shown by the dotted quarter circle. Let us now suppose that we have both horizontal and vertical coils on the ring, as shown in this figure, then the combined effect of these coils will be to produce an oscillating field on the line R R, the strength of the field being, as you will easily understand, about 40 per cent. greater than in either of the former cases; but still the field is not a revolving one. I can show you the production of an oscillating field, as here explained, by means of a mechanical model.

Up to the present, then, we have not advanced in the solution of our problem. We have produced at the distant points an oscillating field, but what we want there is a revolving field, and to get this we must duplicate the apparatus shown in Fig. 9 by putting horizontal coils on the generator and vertical coils on the motor ring, in addition to the coils already there. This arrangement is shown in Fig. 11. Now, the field produced by the coils 1 1 is given by the projection of O n on the vertical, and that produced by the coils 2 2 is given by the projection of O n on the horizontal. The resultant of these two fields is, therefore, O n, the point n revolving round O as a centre on the circle, R. The effect of revolving a real magnet within the generator ring is, then, to produce a revolving magnetic field of the strength O n within the motor ring, a kind of revolving phantom magnet which, for our purpose, is quite as suitable as a real magnet. I can also show you this effect by means of the mechanical model.

You observe that in Diagram 11 four wires are shown, connecting the generating and receiving machines. Now, as the absolute potential of any of these wires may be chosen arbitrarily, there is obviously nothing against choosing it at such a value as will make it coincide with the absolute potential of another wire not belonging to the same circuit. We might thus, for instance, equalise the potential between the wires A and B by connecting them at either terminus, as shown by dotted lines, and not disturb in any way the satisfactory working of the machines. Or, better still, we may omit one of the wires altogether, and use the other as a common wire for both circuits, and thus reduce the total number of wires to three. The common wire must, however, have about 40 per cent. more carrying capacity, since the algebraical sum of the two currents is 1·4 times the strength of each current taken singly. Here you have, then, the theoretical solution of the problem of how to transmit power by alternating currents as indicated by Ferraris, but the first to attack this problem practically was Mr. Tesla, an American electrician, and such motors are therefore also known under the name of Tesla motors, though the name "Ferraris motors" seems to me to be more appropriate, as distinguishing this motor from the two-wire Tesla motors, about which I shall say something presently. To carry out a power transmission by means of such a system, we must have at the generating station an alternator, the armature of which is wound with two circuits giving currents with a quarter-period phase difference, three line wires, and a motor having a laminated field magnet, which is excited by coils placed alternately in the two circuits so as to produce a revolving field. The armature of this motor must have an iron core, surrounded with coils closed in themselves.

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* Cantor lectures delivered before the Society of Arts.

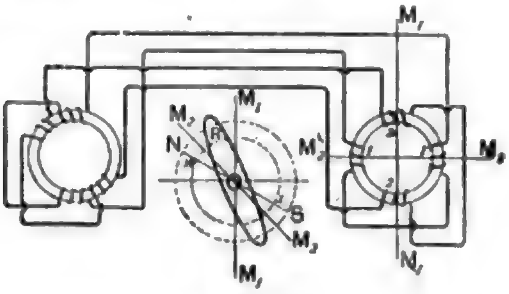

Fig. 10.

The necessity of using three line wires is, to a certain extent, a disadvantage of this system, and several engineers, Mr. Tesla foremost amongst them, have tried to improve the system in such way that two line wires only should suffice. The methods suggested have this in common, that all aim at producing a difference in phase between the currents passing through the motor, without the use of a second set of coils on the generator. If we insert, for instance, a large inductionless resistance to the branch B, in Fig. 10, and a coil having very little resistance, but great self-induction, into the branch A, the current in the coils 1 1 will lag by a small amount behind the E.M.F. impulses of the generator, whilst the current in the coils 2 2 will lag behind these impulses by a larger amount. The phase difference between the two currents can, of course, not amount to 90deg., which angle is required for producing the best effect, but some difference of phase can certainly be produced in this way. The arrangement will, in fact, be equivalent to that shown in Fig. 12, where the distance between the two sets of coils on the generator is less than 90deg.

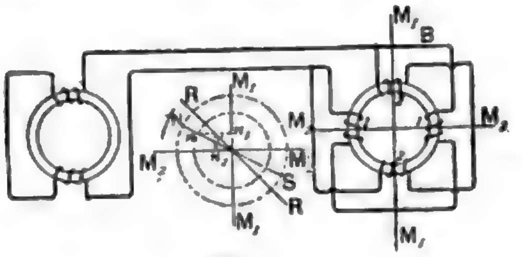

Fig. 11.

An easy geometrical construction, which I need not explain at length, shows that in this case the path of either pole of what I have before called the revolving phantom magnet is an ellipse, but that it can be made to be circular by a dissymmetrical arrangement of the coils on the motor, though in this case the diameter of the circle is much reduced. In either case the value of the machine as a power-producing appliance is also much reduced, whilst at the same time the efficiency must be low, owing to the waste of power in the resistance coil. I can also show you the action of this two-wire motor by means of the mechanical model.

Owing to the low efficiency and small power of the two-wire revolving field motor, its employment is necessarily restricted to cases where these defects are of little consequence, but for the transmission of large powers over long distances it is not suitable. For such a purpose we must have three wires, but this is not a great drawback, since the cost of the line is but little increased by the necessity of splitting up the total weight of copper into three instead of into two wires. The revolving field motor has, however, the defect that it is not self-regulating. Its speed may be anything between zero and that speed which will give synchronism between the two machines accordingly as the mechanical load varies from a maximum to nothing. This defect can be overcome by combining with the armature in the motor a real magnet which will force the armature to keep step with the current, and thus ensure a constant speed at varying loads. The motor will thus start with great power by virtue of the currents induced in the armature winding by the revolving field, and having reached the synchronising speed it will keep there by virtue of the interaction between the revolving field and the revolving magnet; it will, in fact, behave just like an ordinary alternator run as a motor, with this difference, however, that the ordinary alternator, if overloaded by 50 or 100 per cent., will be thrown out of step and come to rest, whereas the combined Ferraris and synchronising motor will always be ready to recover itself after the overload has been removed.

Since the discovery of Ferraris has been made public, many engineers have turned their attention to revolving field motors, and especially to a modification of this principle, according to which three sets of coils are employed instead of two sets only. As far as I have been able to trace the history of this invention, the first to suggest the use of three coils were Mr. Tesla and Charles Bradley. The latter applied in the United States for a patent in 1888, which bears the number 409,450, and was granted on the 20th August, 1889. Next comes Wenström with his British patent, No. 5,423, of 1890, and at about the same time Dobrovolsky, in Berlin, had worked out a similar system. About a year ago, when I visited him at the works of the Berlin Electrical Company, he showed me such a three-wire motor in action, while shortly afterwards Charles Brown, of Oerlikon, took the matter up, and it may interest you to learn that he is at the present moment putting up a 500-h.p. transmission plant on this system between Bülach and Oerlikon, a distance of 15 miles. This transmission is intended to supply all the power required in the Oerlikon Works. The general principle forming the basis of the work done by these various inventors is illustrated in Fig. 13. The generator contains a revolving field magnet, and an armature wound with three distinct coils. The end, O, of each coil is joined to a wire, W, common to all, and the three free ends are joined with the three line wires. At the receiving station there is a three-legged magnet, the coils on the legs being in connection with the line wires on the one side, and joined by a common wire, W, on the other side. It is easy to see that the rotation of the field magnet in the generator will produce successive polarities in the legs of the receiving magnet, and that the general effect will be that of a revolving field. The armature, A, will, therefore, be set in rotation, in the same way as is the case in the original Ferraris motor. This kind of transmission is known in Germany under the name of transmission by the "three-phase current," and it is likely that it will, ere long, become a strong rival to the ordinary alternating current.

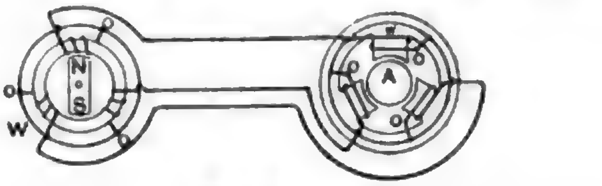

Fig. 12.

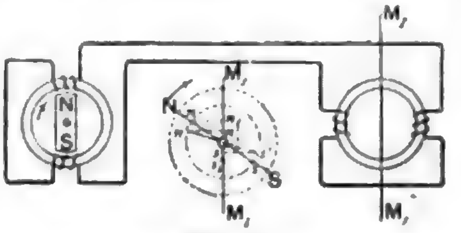

Fig. 13.

The diagrams I have brought before you were all drawn for two-pole machines, as this was the simplest way of making the principles clear; but I need hardly say that, in practice, the machines are made of the multipolar type, in order to bring the speeds down to any desired value.

You will, perhaps, ask why we should go to the complication of three line wires and a totally new type of motor, seeing that, with the ordinary dynamos and motors, such excellent results have been obtained, and that with only two line wires. My answer is that, with this new system, we can greatly extend the distance of transmission. I have spoken a short time ago of the difficulties which the high voltage required in long-distance transmission, raised in connection with the commutators and general insulation of machines. Now, in the three-wire system of transmission, by alternating currents, we have no commutators, and, in fact, not even rubbing currents. One of our difficulties has, therefore, already vanished. As to the other, which has reference to the general insulation of the machines, it is easy to see how this may be overcome. We need only, instead of working direct, work through transformers. The insulation of transformers offers no difficulty whatever. I have here on the table a transformer of the type made by Messrs. Johnson and Phillips, which has been designed specially for high-pressure currents, and is provided with oil insulation. I have recently used two of these transformers for testing a Brooks line. In one transformer the pressure was raised from 2,400 to 17,000 volts, the high-pressure current was sent through the line, and at the other end it was again transformed down to 2,400 volts, and, finally, to 100 volts, for lighting glow lamps. The apparatus was kept running for several days without any difficulty. Mr. Brown informs me that he has with oil-insulated transformers, and even gone up to 36,000 volts, without breaking down the insulation, and the Bülach-Oerlikon transmission will be made at 25,000 volts, whereas the machine will work only at a few hundred volts. There is thus no difficulty in adopting whatever voltage is most economical in each case, and yet avoiding all danger, either to the attendant or to the machines themselves, at the generating and motor station.

I feel that I owe an apology for having occupied so much of your time with discussing a branch of power transmission which to many of you must seem to be purely theoretical and hardly ripe for discussion. My excuse must be that I am very strongly convinced that some form of alternate-current working will be the ultimate solution of the problem how to transmit power—possibly over all distances, but certainly over very long distances—and that I was desirous of directing the attention of electrical engineers to a subject in which much work may still be done.

Electric Machine Tools.

In concluding my lectures, I wish to bring before you a few examples of short-distance transmission as applied to electric machine tools. This branch of our subject has of late years received considerable development at the hands of various English firms, and, thanks to their enterprise and perseverance, is now a well-established method in several engineering works.

As an example I may mention the Leven Shipyard of Messrs. Denny Bros., at Dumbarton, and Mr. Archibald Denny has been good enough to give me some particulars of the work carried on by his firm in this direction. I cannot do better than quote his words: "In our yard and engine works we have numerous instances of electric transmission of power. In our experimental tank we drive our model cutting machine and small lathes by means of a 3-h.p. Immisch motor. In our upholstery department we drive six sewing machines with a 2-h.p. Immisch motor; of course, in this case there is a large margin of power. In our experimental tank we have also used small motors for driving small model paddle wheels in our experimental models, and have obtained in this way most valuable data, which we could not have got by any other means. The power for all this work is obtained from a dynamo driven by an ordinary line of shafting in our joiner's shop. We also use a 3-h.p. motor in the yard for boring the stern tubes in place. Before this we used a portable engine, which necessitated an attendant to fire the boiler and carry water to it."

"During the holidays, when all the boilers are off except one, we occasionally put down a motor for driving some lathes to do repair work, and this saves an attendant at more than one boiler. In our engine works the pattern-shop is driven by a 15-h.p. Manchester motor, the dynamo being driven off the line of shafting in the fitting shop."

You see, Messrs. Denny Bros. find electric power transmission so handy, economical, and convenient, that they make extensive use of it. They employ a special tool for drilling the sole-plates of engines, which I now show on the screen. The weight of the machine is sufficient for the pressure required on the drill, and the whole apparatus being mounted on wheels, it can be rapidly shifted. The machine will drill 1¼in. holes through two thicknesses of inch plate in three minutes.

Another machine used at Leven Shipyard is a special drill for butt straps. The motor and gear are mounted on a stout vertical column with horizontal arm, so as to give adjustment in both directions, the column being bolted to the strap, as shown. The machine will take in straps 50in. deep by 23in. between outer rows of holes, and is chiefly used for drilling sheer strake double butt straps. The outside strap is first punched and countersunk, and the machine drills through the plate and inside strap. The machine is worked by two men—one hole-borer and one labourer—and will do three straps, or about 180 holes per day.

The rivet holes in boiler furnaces are also drilled by an electric tool, which I illustrate on the screen. The machine has a tripod stand arranged to go inside the furnace, but it has also holding-on magnets for outside work. One man with this machine does the work which formerly required three to four men.

No account of electric machine tools would be complete if it did not include the work done by Mr. Rowan, who has been very successful in developing this branch of power transmission. Amongst the improvements Mr. Rowan introduced is that of holding-on magnets, whereby the tools are firmly held in place while at work, and yet by the mere turning of a switch become liberated, and can be shifted to a new position with the greatest ease. You see on the screen some of Mr. Rowland's drillers as applied to ship work. The apparatus is suspended on a chain over the ship's side, and supplied with current by means of two flexible wires. I need not detain you with a description of the picture on the screen, because I can show you the actual machine at work, thanks to the kindness of Messrs. M'Whirter, Fergusson, and Co., the makers, who have sent me one of their latest machines for this lecture.

I am also indebted to Mr. Webb, the locomotive superintendent of the London and North-Western Railway, for the loan of one of his electric tube cutters, which you see before you, and which I shall now work. A diagram of this machine to an enlarged scale is on the wall.

These few examples of what are properly called electric machine tools must suffice for this lecture, but there is another class of apparatus—namely, electric mining machines, which ought to be included in our subject. Several firms, both here and abroad, have of late years devoted considerable attention to the application of electric power to mining operations, such as pumping, hauling, coal-cutting, and drilling. Messrs. Goolden and Co., for instance, have during the last four years steadily and perseveringly worked out many of the difficult problems in connection with this subject, and I am indebted to this firm for the loan of the apparatus you see here, and also to Mr. Atkinson for assisting me in setting the machines up. After the excellent paper which Mr. Atkinson read at the Institution of Civil engineers, only a few weeks ago, it would be occupying your time uselessly if I were to give any lengthy description of these machines. I shall, therefore, merely show two types of mining motor on the screen and show you a drill at work.

I have in these lectures not attempted to treat exhaustively any one branch of the subject, but have rather endeavoured to pass the various branches in rapid review, so that you may know what electric transmission of power can do and what it cannot do. We hear nowadays very frequently the assertion that electricity is but in its infancy, and will ere long be the sole motive power, driving our main-line trains, speeding our vessels across the ocean, and running our factories. These are idle dreams, ideas put forward by persons who have forgotten or have never learned the fundamental laws of nature. Do not waste time over such ideas, for there are other more hopeful problems, such as the utilisation of water power generally, of waste coal at the pit's mouth, the working of railways in mountainous districts, where water power is abundant all along the line, the working of tramways, underground town railways, the application of electric power to such purposes for which now small auxiliary steam engines are employed, and last, but not least, its application to machine tools and other special machinery, of which I have given you examples to-night.

COMPANIES' MEETINGS.

CITY AND SOUTH LONDON RAILWAY COMPANY.

Directors: Charles Grey Mott, Esq., Chairman, Harrow Weald Lodge, Stanmore; Charles Seymour Grenfell, Esq., Elibank, Taplow; Sampson Hanbury, Esq., Langford Park, Maldon, Essex; S. Barclay Heward, Esq., 57, Old Broad-street, London, E.C.; Alexander Hubbard, Esq., Derwentwater House, Acton.

Report and accounts for the half-year ending June 30, 1891, submitted to the half-yearly ordinary general meeting, held on August 11:

In presenting their report and statement of accounts for the half-year ended June 30, 1891, the Directors have to report, with satisfaction, that the railway has been worked during that period without accident to any passenger, or to any of the staff employed. Although occasional delays to the traffic have occurred through defects in the rolling stock or other similar causes, these were at first to be expected during the working of a new and untried system of locomotion, and it is a matter for congratulation that in all these cases the delay has been of very short duration, and the regularity of the working is steadily improving. The receipts during the half-year from all sources amount to £19,688. 2s. 4d., and the expenses for the same period to £15,520. 16s. 5d., leaving a net profit of £4,167. 5s. 11d. The net revenue account shows a balance of £4,693. 3s. 8d., of which amount the interest on debentures absorbs £4,137. 16s. 6d., leaving a balance of £555. 7s. 2d. to be carried forward to the next account. In the beginning of a new undertaking many of the items of expenditure are necessarily high, but your Directors have satisfaction in stating that some of these have already been considerably reduced, and further reductions will from time to time be made, so far as is consistent with the safety of the public and the interests of the Company. During the half-year the number of passengers carried by the railway has been 2,412,343. For a considerable time a uniform charge of 2d. for passengers was adhered to, but it has been found necessary in order to compete with the omnibus and tramway traffic to reduce the charge at certain stations to 1d. during stated hours. This has been found to work advantageously, both in the Company's interest and to the convenience of the public. Two additional locomotives are now nearly ready, and one train of the new carriages has already been received. The completion of these, and the additional generating engine and dynamo now in course of construction, will allow of a considerable increase in the train service. The action taken by the London County Council in November last to contest the right of the Company with respect to the line of frontage at Kennington and the Oval stations has been decided in favour of the Company by the Court of Appeal. The Bill promoted by the Company in Parliament for an extension of the line to Islington failed to pass the Committee of the House of Commons, and the Directors regret that a valuable aid to the traffic of the existing line, and a great accommodation to the public, has been in consequence delayed. Your Directors regret that owing to other engagements Mr. Walter Robinson has decided to resign his seat at the Board, and the vacancy so created has been filled by the election of Mr. S. Barclay Heward, of 57, Old Broad-street, London.

The fourteenth ordinary general meeting was held at Winchester House on Tuesday, Mr. Charles Grey Mott, chairman, presiding.

The report having been taken as read, the **Chairman** said there was one matter connected with the report which he was sure they would have read with satisfaction, and that was that they had been enabled to carry two millions and a half of people during the half-year to which it referred without any accident whatever on the line. He regretted that a few days ago for the first time in the history of that Company a fatal accident occurred, but as the passenger in that case acted in violation of the by-laws of the Company and in direct defiance of its officers, no blame could attach to the Company in the matter. At the same time his hearers might be sure that they (the Board) regretted such an accident exceedingly and sympathised very much with the relatives of the passenger who was unfortunately killed. The past half-year, as they could well imagine, had been a very anxious one to the Board. In the first working of a new system such as that, three points were naturally presented to the Directors of a Company situated as that was. First, would the system of electric locomotion work at all? Secondly, would it work satisfactorily; and thirdly, would it work in such a way as to give a remunerative return to the shareholders for the money invested. On the first two heads the Board could report with confidence in the affirmative. They had worked the railway, and they had worked it satisfactorily. As regarded the last head, he was sorry to say that at present they could not answer with the same satisfaction. They had yet, at some future time, to say that that system was not only efficient, but one that would be a fairly financial success. As they had seen from the accounts, the past half-year had given them a profit which had enabled them to pay their debenture interest in full, and had left a very slight margin beyond. As they had no other preference charges at present beyond the debenture interest, and beyond a very small sum that they might have to pay for the preference shares that might be issued—which, as they knew, was a very small amount indeed—any further profits would go into the hands of the ordinary shareholders. He hoped that the future profits of the line would go on steadily increasing, and that it would not be so very long before he might have the pleasure of standing there and feeling that they had earned a substantial dividend. But that rested with the future, and he did not like to prophesy on these points. They knew he had always refused to do so, and he thought, wisely. He preferred to deal with accomplished facts rather than with any roseate views which might or might not be fulfilled. They might like to have a short *resumé* of their present financial position. The receipts from passengers during the past half-year—and they were the only source of receipts they had at present, because they had practically no other traffic over the line but passenger traffic—had amounted in the whole to £19,403. They had received a small sum from transfer fees, rents, and so on, which brought the total up to £19,637. 10s. 3d. They had earned that by carrying 2,412,343 passengers. The number of passengers per train mile run was 17. If that were an ordinary railway, this would be a very large number; because the general average of the large English railways was only about 3½, the general average of all the lines, including suburban ones, in this country being about five. But, then, their's was a purely metropolitan line, costing very much more, and the traffic upon which was expected to be very much heavier than that of the ordinary railways of the country. They might ask—was their capacity for carrying the traffic utilised to its maximum point? No! With their present train service they could carry three times the present number of passengers if they were spread over the 24 hours. Therefore, they had capabilities of development, even upon their present system of working. Before long they would be running more trains, and if the traffic grew they would be able to take a very much larger number of passengers than they could now. Their earnings per train mile had been 2s. 9d. Of course, the earnings per train mile on a line of this kind ought to be larger than those of the ordinary railways. Unfortunately, at present, they were not, because they were not carrying the relative amount of traffic to those railways which they ought to do. The average passenger receipts on the London and North-Western per train mile were 3s. 3d. Some lines earned more. All the large railways benefited, however, from receipts from other things carried per passenger train, such as parcels, horses, carriages, mails, etc. Their expenses were, as stated in the report, heavier for the past half-year than the present rate of expenses at which they were now working. In the early stages of the system it was necessary that they should have a very large staff to deal with a traffic which was unknown and new. They had also to have expensive men to educate the staff. The reduction in the rate of expenditure was one of the pleasant features of the future. They had, of course, yet to learn the cost of maintenance of some of their stock which was new now. But he did not think it was likely to turn out that they would have a very heavy item of maintenance from their experience so far. Their permanent way expenses were not likely to be so high as those of an ordinary railway. Their locomotive power was at present a point which compared unfavourably with the ordinary working of a steam railway. But he would venture to caution them against taking the amount in their accounts as a permanent and absolutely ascertained figure. It had been difficult, especially in the first half of the year, to ascertain permanent charge for steam engine power, because that power was used for several purposes besides working the locomotives, and absolute division of the charges was difficult; they were estimated rather than ascertained. In the future he hoped to have them settled, and that they would be able to deal more accurately with this account another year than they could now. The expense of running a train mile had been about 11d. With steam this charge varied from about 9½d. to 1s., so that they might be said to be not far from on a par with steam railways in this matter. Of course, however, their (the City and South London) trains were very much lighter, and would not carry so many passengers as the other lines. But as they carried as many passengers at present as they had to carry—they sent none away—they were not losing anything by having smaller trains, and he was not sure but that in the future the system of having light trains run more frequently would in the end prove more economical and more conducive to the public comfort than running so many comparatively empty trains, as was done on an ordinary railway. They had had to contend in this first half-year with a good many difficulties, but they were steadily trying to overcome them. They were not serious, but the small improvements which they were making and hoped to make, would, he thought, render the railway much more popular in the future than it had been in the past. At the same time he thought that anyone who had used the railway would feel that as far as comfort, speed, and all the general accessories of convenient railway travelling were concerned, their line was not inferior to that of any of the ordinary steam railways. They hoped in the future to make it very much superior, and that when all their improvements were carried into effect it would be confessed that they had initiated and brought into use a system of locomotion decidedly superior to any in existence. The great stage coaches of the past had their day, which lasted for some 60 years. They were superseded by steam railways, which had lasted up to the present time for another 60 years, that was, had had their day. It remained to be proved whether electricity was the mode of locomotion that would supersede steam. At all events, they had the satisfaction of knowing that they had tried to do something towards its development, and he hoped it would not only prove a success as far as the public convenience was concerned; but that the time would come when he would be able to congratulate them on its financial success also. They were making improvements in various directions. They had had new carriages built, two new trains of them, and they were now on the ground and being put together ready for working. He thought they would be felt to be a decided improvement on the other ones. Two new locomotives were building, which they also believed would improve the speed and regularity of the trains. Special attention was being paid to the lighting of the latter by electricity. One half of them were now lighted on an improved principle, which would, he thought, be still further developed. Hitherto the electric light had been uncertain, but he thought they were making it certain, and that it would be thoroughly satisfactory for the purpose. They had just fixed two new boilers in position, so as to give them additional power. They had a new engine and dynamo nearly ready for delivery, and before long they would be in a position to cope with the traffic which came to them (as unfortunately all suburban traffic did come) in an irregular manner. In the morning and evening there was a sudden rush of people, and in the middle of the day hardly any passengers to carry. They hoped to get their increased traffic first by disabusing the public mind of the prejudice which very largely existed at present against travelling by an underground railway of that description. When the Metropolitan Railway was first opened they would recollect how very strong was the prejudice against it. People had got over that, but, of course, with a railway (such as the City and South London) which was two stories underground, and worked by a power so little known as electricity, there was a good deal of public prejudice to be overcome. He believed they would overcome it when they had everything in working order, and that the traffic would steadily increase. They hoped to get, and were getting, an increase of traffic from the growth of population on the route. Houses were being occupied along the line, and new houses were being built, and naturally there would be a growth of the population. All railway companies found that increased facilities for traffic produced increased traffic, and, as the expenses of their line would not, he thought, grow in the same proportion as they did upon an ordinary steam railway, they had some hope for the future, though, unfortunately, it was hope deferred at present. One of the most important questions they had to consider was how to fill up the trains during the centre of the day. They had made an effort to do this during the last two or three months, by reducing the fares from 2d. to 1d. at certain stations and at certain stated times. The result had been so far satisfactory, that it had resulted in their carrying from those stations during those times three times the traffic they carried before, and their receipts increased from these stations some 50 per cent. Whether the development of this policy—decreasing the fares at other stations—would produce like results was a question they had to consider very carefully. It was not to the interests of the Company to reduce fares. They regretted to have to alter the plan of a perfect uniformity of fare over the line. They thought they should adjust their ideas to the circumstances of the time, however, and increase the popularity of the line and its resultant receipts. They agreed to go to Parliament for an extension of that line from the City up to The Angel at Islington. That would have been a very good line in itself, and would, he thought, have paid very well, as well as bringing to the existing line a very considerable increase of traffic exactly at the time of day they wanted it. Unfortunately circumstances occurred in the first Committee of the House of Commons which led them to throw out the Bill. There was very slight opposition, the only remaining opponents at last being the Corporation of London, and even they, he believed, did not wish that the Bill should be thrown out. They (the Board) had nothing to do with the circumstances which arose. It was very doubtful whether in their present financial position the Board would come to the shareholders again with a recommendation to go for that extension, because until they had brought up the price of their shares in the market, it was doubtful whether they could obtain the necessary capital. Between this and next session they would have to consider the question, and if they could see their way to carry it out without burdening the existing company, they would prefer to do so. The new plant they were putting down was intended as part of that which would ultimately work the Clapham extension, but the same reason which prevented their going for the Islington line applied to the Clapham one. They would see from the report that the action taken by the County Council—which was a very arbitrary one on the part of that Council, who really had no good case as regarded that Company, the real object being the testing of particular rates which they thought they could try upon a small Company better than a large one—had been successfully opposed by the Company in the first courts, and the result affirmed in their favour in the Appeal Court. Having nothing further to add, he would move that the report and accounts be approved and adopted.

This was seconded by **Mr. Hanbury**.

Mr. Peto was glad to hear the Chairman say they were not going to proceed with the Islington extension. They would not lose anything by waiting to see what would be the result of working the old line. He noticed that they had elected another gentleman to the Board in the place of Mr. Robinson, resigned. He asked, looking at the fact that the railway was a very small matter, was it absolutely necessary to have five directors? He did not want them to work for nothing, but it seemed to him that three would be ample. Adverting to the wages and salaries, he asked whether the work of manager and secretary could not be done by one gentleman.

The **Chairman** said that, unfortunately, they were bound by their Act of Parliament to have five directors, and, moreover, they could not do with less, as three formed a quorum. Though the income of the Company looked small at present, the work connected with it was by no means small. This was a railway that required a very great deal of constant attention and management. They could not do without an efficient staff at their headquarters. They must remember that the number of passengers carried was very large, and the number of trains and the length of time they were run exceptionally so. They were therefore obliged to duplicate the staff in many cases. The latter was therefore necessarily larger than was absolutely proportionate to the traffic. The relative expenses on this head would diminish as the traffic increased, because it would not be necessary to increase the staff. As to the appointment of Mr. Heward as Director in place of Mr. Robinson, that gentleman represented very large shareholding interests in the Company, and had given them the benefit of his advice at the Board for a long time, and had acquired considerable knowledge of the Company's affairs. They thought, therefore, they could not do better than ask him to take a seat at the Board. The Chairman then put the resolution, which was carried unanimously.

The proceedings closed with the usual vote of thanks to the Chairman.

LIVERPOOL OVERHEAD RAILWAY COMPANY.

The half-yearly meeting of this Company was held in Liverpool on Tuesday, Sir Wm. B. Forwood presiding. The report is alluded to in our "Notes."

The **Chairman** referred to the progress of the works during the past half-year, and said he was pleased to say that they had made satisfactory progress indeed. The main structure had advanced south to the Collingwood Dock, in the course of which three important opening bridges had been constructed. The foundations were completed as far south as St. Nicholas Church, and they expected the main structure would be advanced to that point by the end of September or the beginning of October. During the past six months they had erected two miles of the main structure, and the contractor expected that the whole of the foundation for the southern section would be completed within four months. It was somewhat rash to hazard an opinion as to when it would be completed, but he hoped that the forecast which he gave at the last meeting would be realised, and that when the shareholders met again next spring they would be within measurable distance of the completion of their important undertaking. The position of the line on the southern section would be changed somewhat from what it was originally proposed to be. The original plan was to elevate it along the Wapping Dock and warehouses, but by the liberality of the Corporation of Liverpool and the Dock Board they would now be able to keep on the same level all through. That was very important for the successful working of the railway. During the past six months the Directors had given serious consideration to the means of propulsion to be employed, and they had visited various electrical works in the country, including the electric railway now working in London. They had had the advantage of the advice of Mr. Greathead, the engineer of the railway running under the Thames, and after carefully considering the subject, they had decided to adopt electricity, because it would be safer, cleaner, and more economical in its working. Tenders were then invited from the principal manufacturers of electrical machinery, and the Directors had accepted the tender of the Electric Construction Corporation, of Wolverhampton. The electricity would be generated at a central station, to be located near the Wellington Dock, a position which they had been fortunate enough to obtain from the Dock Board. By having their station at that point they could obtain water at an advantage, and they would also have the advantage of having their coal tipped from the railway overhead, without the necessity of constructing buildings, etc. In that way they would save a considerable amount of money. The electricity would be conveyed by a central rail to the motor cars which will compose the train. The journey from end to end, including stoppages, would be made in 25 minutes. In order to safeguard the shareholders as much as possible from the many contingencies which beset railways, a contract was made with the Electric Construction Corporation for working the train at a fixed price per train mile for two years. That in itself was a guarantee that they would work it safely, and at the same time give the best possible machinery. He was sure they would be gratified at the progress of the works. They had had their difficulties, but he was glad to be able to say that these had been surmounted, and now he hoped that there would be no further obstacle to the work progressing with great rapidity, and he really thought that at the next meeting of the shareholders they would be within very near distance of the completion of the railway. With these remarks he begged to move the adoption of the report.

Mr. J. B. Brancker seconded the motion, and it was carried unanimously.

Replying to various questions, the **Chairman** said that the main structure had now been advanced to the Clarence Dock, and the Company had decided to have first and second classes. Fares had not yet been resolved upon. The 3½d. per train mile covered the whole of what were known as the locomotive expenses of the line. It had been the intention of the Directors from the first to open the northern section as soon as it was completed; but a great deal would depend upon the completion of their electrical plant and generating station. In other words, the southern section was being proceeded with so rapidly that it might be completed by the time the electrical equipment was ready, and in that case all sections of the line would be opened together. The Directors did not at present contemplate manufacturing electricity for illuminating purposes, except for their own uses. The line would be lighted by electricity manufactured by themselves, but if they went beyond that they would require a far larger area for generating plant, and they must bring their own business to a state of efficiency before they attempted anything in that direction.

UNITED RIVER PLATE TELEPHONE COMPANY.

The fifth ordinary general meeting of this Company was held on Friday, 7th inst., at Winchester House, Mr. J. Irving Courtenay presiding.

The **Chairman** said the results of the past year's working of the Company had been entirely governed by one factor—the gold premium. The gross income for the past financial year had been £106,259, as compared with £108,612 in the previous year, the difference arising solely from the diminution of their sales business, which, in consideration of the long credits customary in the River Plate, they had not thought it prudent to push. More money had been received from subscribers and messages in the year under review than in the previous year, although there had been a considerable falling off in the total number of their subscribers. No fewer than 1,099 new subscribers came on their books during last year, and he believed they would find their experience to be the same as had been found in other enterprises—that the subscribers who came on during a period of financial tightness were more permanent subscribers and were better payers than those who came on during a period of inflated commercial prosperity. Their working expenses in the River Plate had been £56,941, a reduction of £6,566 compared with those of the previous year. This reduction of 10 per cent. had been the result of economies, notwithstanding the increased cost, to a considerable extent, of materials, general expenses, and taxes. Further economies to some extent were anticipated, but unless a reduction occurred in the gold premium a greater degree of expenditure must be expected. This would necessitate such a rise in their rates as would at least meet the increased expenditure. He regretted that the Directors were unable, for the first time in the Company's history, to declare a dividend. This was entirely owing to their loss on exchange, which had amounted to £36,049, or nearly 12½ per cent. on the Company's paid-up capital. With only a slight revival of commercial affairs in Buenos Ayres and a fall in the gold premium, the Company would soon again be in a dividend-paying condition. Telegraphic advices from Buenos Ayres, dated the 4th inst., stated that their receipts for July had been better than those for the same month of last year. The report and accounts were adopted.

CUBA SUBMARINE TELEGRAPH COMPANY.

The fortieth ordinary general meeting of this Company was held on Wednesday at the offices, 58, Old Broad-street.

Mr. Thomas Greenwood presided, and stated that the receipts for the half-year to June 30 last were not so large as those for the corresponding period of the previous year. This had been owing not to any want of trade, but to the impediments caused by the breaking down of one of their cables. As, however, they now had their cables duplicated from end to end, it was highly improbable that such a circumstance would occur again, and therefore they might look to their revenue continuing. The repairs had been completed during the half-year, and the charge had been rather less than in the June half of 1890, the result being that they had rather a larger sum to carry to the credit of the reserve fund. That fund now amounted to £78,000. They had expended about £22,500 on new cable, and, therefore, but for this outlay, which really was properly invested for use, their reserve fund would amount now to rather over £100,000. The suit with the Spanish Government made slow progress; and he could not say when the case would come on for hearing. The delay was not very prejudicial to them—in fact, all that they wanted was that there might be perpetual delay. They wanted a decision that the Government had not the right to grant the concession which they opposed, and, until this matter was decided against the Company, they were going on with their business, and their opponents could do nothing. He concluded by moving the adoption of the report and accounts, which was seconded by **Mr. A. F. Low**, and carried unanimously.

Dividends for the half-year at the rate of 10 per cent per annum, subject to income tax, on the preference shares, and at the rate of 8 per cent. per annum, free of income tax, on the ordinary shares, were declared.

MONTEVIDEAN AND BRAZILIAN TELEGRAPH COMPANY.

A general meeting of this Company was held on Tuesday at the offices, Copthall-avenue, when the report and cash account of the liquidator, Mr. George Fraser, were approved and adopted.

CITY NOTES.

Brazilian Submarine Telegraph Company.—The receipts for last week amounted to £4,243.

Western and Brazilian Telegraph Company.—The traffic receipts for the week ending July 31 were £2,696.

City and South London Railway.—The receipts for the week ended the 8th inst were £821, against £692 for the week ending August 1.

Western Counties Telephone Company.—The half-yearly warrants for dividend to June 30 last, on the preference shares of this Company at the rate of 6 per cent. per annum were posted on Saturday the 8th inst.

NEW COMPANIES REGISTERED.

Energy Gas, Electric Lighting and Power Company, Limited. Registered by A. Horbelet, 5, Chancery-lane, W.C., with a capital of £20,000 in £1 shares. Object: to acquire certain patents relating to gas lighting, and to develop and work the same: to carry on the business of mechanical engineers, etc. Registered without articles of association.

PROVISIONAL PATENTS, 1891.

August 4.

13163. **Improvements in carbon transmitters for telephonic purposes.** William Blenheim, Egham, Surrey.

13171. **An improved socket for incandescent electric lamps.** John Criggal, James Berkley, and Charles Frederick Williamson, 34, Southampton-buildings, London. (Complete specification.)

13200. **Improvements in fence posts, telegraph posts, or the like.** George Cecil Dymond, 6, Lord-street, Liverpool. (Frederick Peter Rosback and Henry Frederick Band, United States.) (Complete specification.)

13208. **Improvements in the manufacture of wire, bars, bands, and sheets of copper by electrolysis, and in apparatus therefor.** Edward Casper, 4, South-street, Finsbury. (Emilo Viarengo, Italy.)

August 5.

13250. **Improvements in electrical switches and safety fuses.** William Humphrey Wheatley, 40, Chancery-lane, London. (Alfred Ashfalck, Germany.)

13252. **Improvements in electrical contact making and breaking devices.** Charles Féry and Eugène Ducrotet, 45, Southampton-buildings, London.

13268. **Improvements in electrical fire alarms.** William Wilson Horn, 151, Strand, London. (Brunswick W Leonard and John C. Nichols, United States.)

13269. **An improvement in connecting the conductors of electrical glow lamps.** Edward Alfred Gimingham, 28, Southampton-buildings, London. (Complete specification.)

August 6.

13274. **Improvements in electric meters.** Pares Eugene Singer, 6, Victoria-road, Kensington, London.

13280. **Improvements in electrical conduits and conductors.** John Mackintosh Mackay Munro, 154, St. Vincent-street, Glasgow.

13315. **Improvements in arc lamps.** James Yate Johnson, 47, Lincoln's-inn-fields, London. (Charles Bellens, France.) (Complete specification.)

13331. **Improvements in telephony, and apparatus therefor.** Milo Gifford Kellogg, 24, Southampton-buildings, London.

August 7.

13335. **Electric tell tale for the control of mast head, stern, and side lights on steamers.** Léon Harry Cline, 52, Crowle-street, Hedon-road, Hull.

13362. **Improvements in dynamo-electric machines.** George Forbes, 34, Great George-street, Westminster, London.

13366. **Improved telephone transmitter.** John Dunham Massey, 31, Lombard-street, London.

13367. **Improvements in electric telephone switches and systems.** Thomas Beaven Sloper, 323, High Holborn, London.

13371. **Improved electro manual devices for the actuation of gravity signal arms, points, and the like.** Henry Harington Leigh, 22, Southampton-buildings, London. (A. Hillairet and Albert Hugnet, France.) (Complete specification.)

13372. **An improved electric or galvanic brush.** Arthur Hervey Byng, 55, Chancery-lane, London.

13384. **Improvements in electrical contacts.** George Forbes, 24, Southampton-buildings, London.

13387. **Improvements in dynamo-electric generators.** Jean Henry Cazal, 40, Chancery-lane, London.

August 8.

13437. **An improved method of and means for electrical communication between parts of railway trains.** Arthur James Howes, 11, Furnival-street, London.

13442. **An improved wave power motor.** William Wilson Horn, 151, Strand, London. (Henry P. Holland and Jacob A. Fischer, United States.)

13446. **An improvement in secondary voltaic batteries.** William Joseph Starkey Barber-Starkey, 28, Southampton-buildings, London.

13460. **Improvements relating to the coating of articles with a new metallic alloy by electro deposition.** The London Metallurgical Company, Limited, and Sherard Osborn Cowper-Coles, 45, Southampton-buildings, London.

SPECIFICATIONS PUBLISHED.

1890.

11065. **Impregnating organic, etc., matter by an electric current.** Oncken. 8d.

12832. **Electrical meter.** Wilson 8d.

14404. **Electrical switches.** Snell. 8d.

14411. **Secondary batteries.** Niblett. 8d.

14484. **Electric switch, etc.** Evered and Rudling. 8d.

14696. **Telegraphic relay.** Bayly (Treber) 8d.

14698. **Electrical conductors.** Crompton and Chamen. 1s. 3d

14830. **Accommodating electric wires in buildings.** Walton. 4d.

16279. **Electrical casting of metals.** Slawianoff. 8d.

18904. **Magneto-electric telephone apparatus.** Fraser. 8d.

19749. **Electric lamps.** Turner. 8d.

20329. **Electrical transformers.** Woakes. 6d.

1891.

7353. **Electric railway systems.** Bayly (Weems). 8d.

10227. **Electrical conductor.** Holmes. 4d.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Brush Co.	—	2⅛
— Pref.	—	1½
India Rubber, Gutta Percha & Telegraph Co.	10	19⅛
House-to-House	5	5
Metropolitan Electric Supply	—	10
London Electric Supply	5	1⅛
Swan United	3¾	4½
St. James'	—	6¾
National Telephone	5	4⅝
Electric Construction	10	7¼
Westminster Electric	—	5

NOTES.

Portraits.—The *Electrical World* for August 8 contains a speaking likeness of Mr. W. M. Mordey.

Omagh.—The Town Commissioners of Omagh are desirous of having particulars of the cost of lighting the town by electricity.

Power from Niagara.—It is proposed to transmit power electrically all the way from Niagara Falls to the forthcoming Chicago Exhibition.

Lisburn (Ireland).—The gas company of Lisburn have advanced the price of public lighting. The authorities are considering the question of electric light.

Fleetwood.—At the last meeting of the Fleetwood Improvement Commissioners the correspondence upon electric lighting was left over till next meeting.

Chertsey.—The gas lighting of Chertsey has been settled for this year at £3. 3s. per lamp. The question of considerable extension to Addlestone is to be considered next year.

Telephone at Clitheroe.—The Clitheroe Watch Committee refused to take any part in the connection of the police office with the workhouse by telephone as proposed by the Board of Guardians.

Nomenclature.—Confusion—we mean no joke—is often experienced between a fuse and a fuse; that is, between a fusible strip, and a box with terminals to contain it. It is proposed to call the former "fuse links."

Sophia.—Premiums of 10,000, 7,000, and 5,000 francs will be awarded by the authorities of Sophia for schemes of lighting that town, the said schemes to remain the property of the town. The plans will be opened on 28th December, 1891.

Felstead School.—A complete installation is being erected for the lighting of Felstead School by Messrs. Drake and Gorham. The lighting is being extended, not only to the school, but to the chapel, gymnasium, infirmary, and other outbuildings.

Brazil.—A sample electric railway installation has been sent to Brazil from the United States, consisting of one car with 25-h.p. motors, a 50,000 watt generator, and entire equipment for a 1½-mile track. If successful, complete plant for 60 cars will be required.

Bewdley.—The Bewdley Watch and Lighting Committee reported that the offer of the gas company to light the public lamps for the eight months from September 1st at £2. 10s. a lamp had not been accepted by the committee, which hoped to make more favourable terms.

Electric Advertising.—The whitewashed walls of tunnels are used in Chicago in a novel advertisement. On the centre of the roof is a wire placard, arranged in such a way that the glare from the electric light casts huge shadowed letters on the wall. Enterprising advertisers may note.

Central Station Arrangement.—We notice that a work on central stations, by M. G. P. Anney, entitled "Manuel Pratique de l'Installation de la Lumière Electrique, Stations Centrales," has been published in Paris (B. Tignol, 53, Quai des Grands Augustins, Paris, 7f.), with 99 figures and 10 plates.

Lynton.—The Devon Electric Lighting Company intend to apply to the Board of Trade for a provisional order to supply electric lighting to Lynton and Lynmouth. The application will be made in November. Ventilation shafts have been affixed to the present electric lighting plant, and other improvements are being made.

Electric Lighting in Ireland.—The seaport of Larne has been lighted by electricity. This is the first town in the North of Ireland which has adopted the new light. This installation, like that of Carlow, has been carried out by Messrs. J. E. H. Gordon and Co.

Dover.—At the last meeting of the Managing Committee of the Dover Town Council, a letter was read from the Brush Company, stating that the letter of the Council's *re* electric light was under consideration, but that time was required to give a satisfactory answer; and also that one of the company's engineers was about to visit Dover and report.

Bahia.—We notice that the *Moniteur Industriel* (Aug. 13) gives particulars of a contract invited by the State of Bahia, Brazil, for public lighting—no system mentioned—from the 9th May, 1892, the contract with the Bahia Gas Company expiring at this date. The contracts are to be in the hands of the secretary, Manoel Pedro de Rezende, Bahia, by 30th of this month.

Alternate-Current Motors.—Readers of the patents column may see that two specifications were accepted last week for alternate-current motors, one being the complete specification of Dolivo-Dobrowolski, and the other a motor invented by Mr. Arthur Arnot, of Australia, which we mentioned a few weeks ago. There is also an improved generator for multi-phase currents.

Sydenham.—A new company has been brought out this week, the Electric Installation and Maintenance Company, for the supply of electricity to the Crystal Palace and the district of Sydenham. The capital is £100,000 in £10 shares, of which Messrs. J. E. H. Gordon and Co., who are contractors to the company, are to take over a thousand as part payment of plant.

Liverpool.—The Liverpool Electric Company have objected to certain charges made by the Liverpool Corporation for the repair of roads. It was stated at the meeting of the Health Committee that the Corporation were on the safe side, as the company had deposited £500, from which the amount could be deducted. If a dispute arose, the Board of Trade would arbitrate.

Barnsley.—At the last meeting of the Barnsley Town Council, the minutes were read of the Park and Lighting Committee meeting held July 31. The borough surveyor laid before the committee a scheme and plan prepared by him for the supply of electricity to a smaller area than the one referred to in the Barnsley Electric Lighting Order, and the committee adjourned the consideration thereof until their next meeting. The minutes were confirmed.

Glasgow.—At the Glasgow Town Council meeting last week, it was stated that at the meeting of the Gas Committee it was decided to take the advice of Sir William Thomson with regard to various matters which had recently cropped up, and which were of vital importance to the question of the electric lighting of Glasgow. Under the circumstances, Councillor Colquhoun agreed to delay for a month the motion standing in his name with reference to electric light.

Collodion in Electroplating.—In a recent patent, Herr Falk, of Berlin, claims the use of photographic collodion as a conducting layer to be applied upon the body to be plated. After drying and exposing to the light the silver salts are reduced by the sulphate of iron, and produces a metallic surface. This process is often described in lectures on physics, and has been employed more particularly, it is said, for some time back to the plating of flowers and insects.

Electric Cure for Sciatica.—A correspondent of a medical paper says that if the positive pole of a galvanic battery having the pole (carbon preferred) covered with absorbent cotton and moistened with chloroform be put over the parts suffering from sciataca, and five to 10 milliamperes of current passed through it every other day for a short time, a cure will be effected, providing there is no constitutional trouble. The negative pole can be applied at any suitable place.

Storage Cars in America.—Storage cars will soon be again seen in New York. The recent decision as regards the Brush patents is responsible for this action, and, in addition to the 16 cars formerly used, it is stated that the whole of the Fourth-avenue route will be equipped by accumulator cars. Washington is to have 44 such cars at once, and Indianapolis and New Orleans are to have trial systems. A battery system is also to be established at Newton, Massachusetts.

A Theatre Struck by Lightning.—At Grosswardein, in Hungary, on Monday, a flash of lightning struck the theatre during a performance. The audience, believing the house had taken fire, rushed to the doors, the consequence being that a number of women fainted and fell under the feet of those in the rear. Happily, some of the more cool-minded among the audience were able to reassure the crowd, and no serious injury was done. The performance, however, could not be continued.

Death of an Australian Electrical Engineer.—Mr. Henry E. Dickenson, of Sydney, met a sad death when attending to the electrical machinery at the Australia Hotel, Sydney. He accidentally fell off the stage, striking his head against some ironwork. Mr. Dickenson was recently elected secretary to the Engineering Association of New South Wales. Previous to his appointment as engineer-in-chief to the Australia Hotel, he was engineer in the Patents Office. He was 46 years old, and leaves a widow and child.

Atmospheric Electricity.—It is usually thought that there is a normal diurnal variation of the atmospheric electricity in calm weather and a clear sky. M. André, however, has given publication to observations made with a Mascart registering electrometer, which do not confirm these views. The fact seems to be, according to these observations, that there are three physical causes for the variation: direction and force of the wind, barometrical pressure, and amount of water vapour in the air; and that corrected for these there is no diurnal variation.

Double Cylinders.—A new idea in compound engine practice, almost as radical as that of compounding itself, has been put into practical use by F. W. Johnstone, superintendent of the Mexican Central Railway. In this the high-pressure cylinder, of 14in. diameter, is enclosed within the low-pressure cylinder of 30¾in. diameter, giving effective area equal to a cylinder of 24¼in. diameter. The stroke is 24in., and the two rods of the low-pressure cylinder are coupled with the single high-pressure rod to one cross-head. A test of 12 trips is stated to have shown an economy of 25 per cent. in fuel.

Electric Railway Material.—The progress of electric railways in America is well illustrated by a complete catalogue of material for their construction, issued by the Electric Merchandise Company, of Chicago. Testing sets, meters, resistances, lightning arresters, switches, fuses, headlights, and gongs, down to celluloid checks for passengers, are all illustrated in their latest forms, besides trolleys of ingenious make, carrying posts of wood and lattice—plain and artistic—ratchets, insulators, and cables. It would form a good guide to the present method of carrying out electric railway details.

Penzance.—The Lighting Committee of the Penzance Town Council on August 12 reported that they considered the time had arrived when it was advisable that the lighting of the borough should be in the hands of the local authority. After having thoroughly considered the respective merits of gas and electricity and the probable cost of obtaining the necessary orders, acquiring and erecting plant, they recommended that within the forthcoming session application should be made to the Local Government Board for powers for gas. After a long discussion the report was referred back to the committee for reconsideration.

Tulse Hill.—The residence of Mr. G. Mason, Glenthorne, Tulse Hill, has been very thoroughly fitted with electric light by Messrs. F. and C. Osler. Some time ago a 60-light plant was put down, and this has now been extended. The engine-room, 70 yards from the house, contains a Crossley 9-h.p. nominal gas engine, and the current is generated by an Elwell-Parker dynamo. A battery of 53 E.P.S. cells provides for storage. The switches are Osler's glass covered and Edison-Swan tumbler pattern, and the fittings are of handsome design. Cigar lighters and other little accessories make the installation a very complete one.

Saw Mending by Electricity.—The hardest steel at present successfully worked by the electric welding process is the welding of band saws. Besides the regular work of making the joint in continuous band saws, it has been ingeniously adopted for replacing broken teeth in finished saws. Formerly it was necessary to cut down to a smaller size any saw from which one or two teeth had been broken, thus losing not only the difference in price between the two saws, but also the entire cost of the labour in cutting the original saw. Now when a tooth is broken out, they simply fit in a new tooth, which is electrically welded in place, and a drop of oil applied as the completion effectually restores the temper of the saw to a serviceable point.

Search Lights in War.—While glancing recently at an able paper on the engrossing subject of ships *versus* forts in naval warfare, we were glad, says a technical contemporary, to find that the author was of opinion that a little less expenditure on big guns and a little more on large search lights would be distinctly advantageous; and the reader was asked to imagine the utter bewilderment of the captain of an ironclad endeavouring to force a narrow passage at night time in the glare of half a dozen well-handled projectors. An involuntary testimony to the value of the search light as a means of defence was, indeed, given recently by the loss at Cherbourg of a torpedo boat, which was cut in two by a cruiser whose captain was dazzled by the rays of a search light.

Telephoning on Telegraph Wires.—An adaptation of the telephone to existing telegraph lines has just been successfully completed between Grangemouth and Glasgow by Mr. J. Erskine Muirhead, of Glasgow. The telephones used are the French type, with microphones. The line has two intermediate stations, one at Port Dundas and the other at Kirkintilloch, but this in no way impaired the speaking; indeed, it is proposed to add other two intermediate stations, making six telephones served by a single line. Though the telegraph instruments were employed simultaneously, there was no interruption; and it is intended that the telegraph instruments shall be discarded. Another feature of the adaptation is that as the wire runs along the canal, the barger can fix a portable telephone on it at any place and speak to the termini.

Free Lighting.—A plan has been thought of by some ingenious people for granting almost free public lighting, and obtaining a business benefit at the same time. The Ashton Town Council have been applied to by the Acme Advertising Company to place tasteful advertisements on the top of the 400 lampposts in that town at a price which will go to greatly reduce the cost of public lighting. A sample advertisement has been put up, and the proposal, appealing as it does to the constant desire of councillors to reduce taxation, is under consideration as to whether the intrusion of such tactics would lessen the dignity or irritate public feeling, or, on the other hand, prove a useful scheme for reducing the lighting rates. It may be remembered that the public kiosks in Paris have a considerable income from advertisements.

Electric Light at Sea.—A complaint regarding the behaviour of the electric light at sea has been made to the Trinity House by the Shipmasters' Society. The Elder Brethren are informed by Lieut. Froud, secretary to the society, that members in active service passing between the Thames and the sea have often represented to the committee the poorness, sometimes invisibility, of electric lights during certain conditions of hazy atmosphere, while the oil lights of lightships and the gas lights of seaside towns have been comparatively bright and distinct. Fault, on the other hand, is also found with the intense and blinding effects of such lights as those of the South Foreland on vessels near at hand. The glare of the electric beam is said to cause ships to cast intense shadows, and to produce a phantom-like appearance of hulls, masts, and sails.

Patent Office.—It is fairly well known that the revenue of the Patent Office is much greater than its expenses, but the exact figures are surprising. Last year the income was £192,606 and the expenditure £83,240, leaving a profit of £109,606, or 56 per cent. of the receipts. This disclosure will no doubt result in an outcry for the reduction of fees, but it might very well result also in a movement for the better examination and testing of the novelty and validity of inventions. It is notorious that the British Patent Office will practically accept any invention, and a case was recently disclosed in which an application for a patent was granted for making gold out of chopped straw. Leaving aside such eccentricities, inventors usually do not feel safe in England as to the priority of their patents, until the patent in Germany, where the scrutiny is far more strict, is granted.

Great Yarmouth.—An advertisement to probable customers is inserted by the town clerk of Great Yarmouth in the local paper, in which it is stated that the Electric Lighting Committee are considering the question of providing an electrical supply for the borough, and are desirous of ascertaining the requirements of the public. Persons wanting a supply are therefore requested to communicate their requirements to the borough surveyor on a form to be obtained at his office. The advertisement goes on to state that the Town Council, as they are at present advised, consider the cost of electricity—light for light—about equal to that of gas at the rates paid within the borough, but persons proposing to take a supply are cautioned that the public generally expect a much more brilliant light from electricity than other modes of lighting, and that this probably increases the cost about 30 per cent.

Harwich.—At the quarterly meeting of the Harwich Town Council, the Mayor was questioned as to the probable cost of lighting the town by electricity. Mr. Parsons, who avowed himself quite in favour of the lighting by that power, provided that the cost was not too great, thought they ought to know the probable cost, so that at the next meeting, on August 27, they would then be able either to vote in favour of or against it. The Mayor said that in the first place there would be a fee of £50 to go to the House of Commons to get their sanction, and then it would afterwards depend upon what opposition was offered to the use of electricity for lighting purposes. Mr. Rose said that the affair had already been before them and settled, so far as the committee was concerned, though he did not say they were going to accept Messrs. Crompton's tender. The Mayor stated the first expense would be 50 guineas for a fee, which Mr. Parsons said was all he wanted to know.

Electric Cars at Clapham.—The Jarman electric cars would seem to be likely to be adopted practically if we are to believe the statements in the daily press. We may premise, however, that this is not by any means the first trial trip, nor, on the other hand, is there anything to prevent the tramways continuing their use if they prove successful and economical. The following is the note referred to: "South London has an electric railway and, if all goes well, will soon possess electric tramcars. By permission of the London Tramways Company, a trial trip was made between High-street, Clapham, and Tooting of a car belonging to the Electric Tramcar Syndicate, and the experiment proved wholly successful. The journey to and fro—a distance of about six miles—was accomplished in some 50 minutes, but at no time was the road clear of traffic, and at several stages the vehicle had to be stopped. The maximum speed attainable is 16 miles an hour, the normal being from seven to eight. An important feature conducive to safety is that in a moment, by manipulating a switch, the motive power can be reversed. Outwardly these cars resemble those ordinarily drawn by horses. In all probability a start with them will be made at Croydon."

Technical Schools.—The council of the Manchester Technical School appointed a committee to visit various technical schools in England and on the Continent. The report of this committee has been presented to the Manchester Whitworth Institute in the form of a full pamphlet, giving details and, what is extremely useful, plans of the schools and laboratories visited. These comprise five technical institutions in Berlin, two at Chemnitz, three at Stuttgart, six at Zurich, two at Winterthur, and one each at Muhlhausen, Crefeld, and Roubaix. Besides this there are in London the City and Guilds Central Institution, the Finsbury College, King's College, and the Polytechnic, Regent-street; and in the provinces the Bradford Technical College, and the technological department of the Yorkshire College, in Leeds. In their general conclusions the committee say that, measured by our standard, the fees are nominal, and in some cases (as Roubaix) there are not only no fees, but all materials are supplied. The danger to our industries from the greater technical instruction is by no means imaginary; for instance, three million pounds in chemicals are imported from Germany and Switzerland, and there is no sound reason, except want of high technical training, why these should not be made in England. They were especially struck with the splendid Polytechnical School in Zurich, and they submit that Manchester similarly requires a technical school of the highest character. No pretence can be made that these schools can be self-supporting; rather on the other hand, the lower the fees, if properly safeguarded by examinations, the more service they can render to the community.

Fatal Electric Light Accident.—An inquest was held at St. Bartholomew's Hospital on Thursday last week on the case we have already mentioned respecting the death of Kate Wilkins, aged five years, the daughter of a watch case maker, residing at 103, St. John-street-road, Clerkenwell. The deceased was passing the Agricultural Hall, Islington, when an electric lamp, weighing 28lb., fell from the top of the hall and struck her on the head. She was knocked down and rendered insensible, and was conveyed shortly afterwards to the hospital, where she died. Mr. William Cumming, a gasfitter, who saw the lamp fall, was of opinion that the rope wire produced (which was 38 strand) was not sufficient to bear the weight owing to the length the lamp was suspended. He would not be surprised to hear that the wire rope had been tested to carry a ton weight, but it all depended what length of wire the weight was hanging upon. William Trickett, electrical engineer, stated that he was responsible for the fixing of the lamp, and on the day in question it was pulled tight to the window-sill. It had previously been suspended from the top of the building. The witness was of opinion that there had been a leak in one of the wires, and that the current had gone to earth and passed to the stone coping. The result was that the wire was burned clean through by the current, and the lamp fell. The reason that the lamp was suspended from the window-sill was because the wire rope had run off the pulley at the top that day, and there had been no time to refix it. After the lamp fell the wire was found to be hot, and on opening the strands a piece of string which ran down the middle of the wire was burned. The switch by which the current was connected was in a brick wall, and witness was of opinion that the current escaped at that point. The wet weather would greatly help the current to pass by way of the coping. The switch was 200ft. away from the point where the wire burned through, and he had never before heard of a similar occurrence. It was a thing almost impossible to provide against, as it was so improbable that it would happen. A verdict of "Accidental death" was returned.

Taunton Exhibition.—The catalogue of the Taunton Electrical Exhibition is a handsome affair, containing many local advertisements and much useful information, with illustrations upon electrical topics. The exhibition is primarily constituted for the better spreading of a taste for and knowledge of electric light and power, and naturally bears largely on the work of the Taunton Electric Company, so successfully worked by Mr. Massingham. This installation is fully described in the catalogue, and its development and benefits set forth. The following are the exhibitors: The Italian Art Fittings Company, Exeter, have hammered brass and copper fittings; Rashleigh, Phipps, and Dawson have art metal fittings and their ray diffuser; the Steam Loop Company show a working model steam loop; Automatic Screw Company, electrical screws; E. Goodman and Son are the printers of the catalogue; Dart Bros., spectacles for examining arc lights; American Camera Company show students' apparatus; King, Mendham, and Co., influence machines and apparatus; John Taylor and Sons, Nottingham, the "Midland" gas engine; Furnival and Co., Reddish, the "Express" gas engine; Davis and Sons, Bath, switches, motors, and apparatus; T. Jenner, Taunton, has many novel inventions—protective switches, self-tightening grip-tools, patent holders, etc.; the Blackman Ventilating Company; Andrew and Co., 6-h.p. Stockport gas engine; Jos. J. Armfield and Co., Ringwood, turbines and turbine gear; Richard Frères, registering meters; F. M. Newton, "Taunton" dynamo and motors driving various machines; G. Gilkes and Co., Kendal, 25-h.p. turbine. The City of Bath Electric Lighting Company have, of course, one of the largest exhibits, containing all manner of electric lighting apparatus, and the Exeter Electric Light Company have a show of electroliers. The Keys' Electric Company exhibit motors doing churning, knife-cleaning, and so forth; James Beach, Taunton, electroplating; Easton and Waldegrave, 3-h.p. engine and boiler for electric lighting; Appleton, Burbey, and Williamson show contractors' supplies—one to 4,000 amperes; Babcock and Wilcox Company have a model of their boiler; and Laurence, Scott, and Co. show their "Norwich" motors, dynamos, and switches.

Electric Lighting in London.—Nothing will awaken the minds of the public in general to the immense spread of electric lighting in London more than an exhaustive article in the *Times*, except, perhaps, the sudden appearance of arc lights down the Strand. The latter phenomenon we have not as yet. Trafalgar-square must await its enlightenment. But the *Times* this week (Aug. 19) has vigorously taken the matter up, and in an ably written article on the "Growth of Electric Lighting in London," and by a leader upon the subject, has drawn the world's attention to what has been gradually though rapidly happening in the metropolis. Three years ago, in 1888, only one electric supply company, the Grosvenor, was worth calling the name. In these three years, in London alone, electricity supply companies have been formed with an aggregate capital of £3,000,000. Instead of one station we have 16, and the 6,000 lamps then lighted from Bond-street have grown to 240,000, with over 240 miles of underground copper mains. Adding the private installations, the careful enquiries made by Mr. Frank Bailey, engineer to the Metropolitan Company, went to show that a total of 325,000 lamps of 8 c.p. might be taken as the total of total, besides 1,000 arc lamps. It is evident that the electric light has "come to stay." The article goes very thoroughly into the different systems of the various stations, from the 10,000 volts of Deptford to the 100 volts of Whitehall. The Chelsea Company of all the suppliers has combined high pressure with continuous current. "Upon the face of it," says the writer, "such a system, combining economy in mains with the principle of 'storage' and the other advantages of direct current, would seem to have hit the right nail on the head, and to be destined to a great future. Strangely, enough, however, there is not a system of distribution in London that has fewer friends amongst electrical engineers"—due, we may imagine, to the comparatively extreme complexity of the regulating appliances hitherto judged necessary. The article comments upon municipal undertakings, pointing out that local authorities can borrow money at 3 or 3½ per cent., whereas electric shareholders expect, and may receive, up to 10 per cent. The paper concludes with a comparative table of the various electric light companies of London, with particulars of capital, horse-power, lamps, mains, and districts.

Keys' Company's Catalogue.—We are in receipt of the catalogue just issued by the Keys' Electric Company, Charing Cross road. This is very full and very varied, but is in the rather cumbrous form of a score or so of separate pamphlets, covered back and front with advertisements; and not being numbered or indexed at all, and of the same appearance, they are a little awkward to refer to. They have their convenience, however, as each department is to itself. Accumulator plant shows regulating switches, automatic cut-out, and testing bell; insulators and insulator bobbins, electric casings, flexible cords are illustrated by a pamphlet a piece, while the item switches have a whole flock—the "Paisto" switch, the "Royal" switches—a neat and business-like quick-break—ship switches, china-base, "see-saw" switches, decorated house switches, two-way switches, flexible switches, main knife-edge switches, besides which are some really magnificent specimens of station switchboards. One of these—"Switchboard No. 71"—has the appearance of a veritable signalman's box. It was made for the Madrid central station for two dynamos of 1,800 amperes and four of 1,200 amperes, for the three-wire system, for the supply of current to 22,000 16-c.p. lamps at one time. The whole board cost about £1,500. Switchboard No. 72 is for a low-tension system with accumulators, and was made for the Asia Quay, Hamburg. Switchboard No. 73 is a handsomely moulded arrangement for ordinary house installations for dynamos and accumulators, in carved work, with switches, instruments, and cut-outs, both solidly and tastefully arranged. Lampholders are of course illustrated. The Keys' Company have a speciality in incandescent lamps which they term the "Star," of which 5,000 a day are made. They are made for export only in England in 4, 6, 8, 10, 16, 20, 25, 32, 50, and 100 candle-power. The "Luna" arc lamp seems simple and easily adjusted; several arrangements of suspension gear are shown. Amongst the more particular specialties are the "Berlin" dynamos, electric motors applied to a greater variety of purposes, a very complete set of electric lighting arrangements for theatres—including stage regulators, group regulators, temporary connections, supplementary lights, three-light stage effects, hanging lamps, etc. The catalogue of the very ingenious and manifold physical apparatus designed by Dr. Edelmann for research and laboratory purposes is a perfect mine of description of valuable and interesting instruments.

Egremont.—Messrs. Nicholson and Jennings, electric engineers, Newcastle-on-Tyne, have been in communication with the Egremont Local Board as to electric lighting by water power, for which 40 brake horse-power would be required. At the last meeting of the Board the clerk said Mr. Boyd, the surveyor, supplied the following particulars, which were forwarded to Messrs. Nicholson and Jennings: "I have, as requested, seen Mr. Head, the millwright, with reference to the power that can be got from the River Ehen at Egremont, and his opinion is that the paper mill in the parish of St. John's, belonging to Mr. Thos. Grice, of Bootle, and at present occupied by Jos. Ramsay, is the best and most suitable place. There is a good waterwheel ready, only requiring a little repair, and he calculates that in summer, at least 30 h.p. is available and in winter 60 h.p. On the 11th inst. I gauged the quantity of water going over the weir at this mill at 11 a.m., and found it to be about 3,000 cubic feet per minute, and there is 10ft. of fall at the wheel, which gives 34 h.p. On the same day at 12 noon I gauged the water passing at the Bleach Green weir and race, and found it to be 2,500 cubic feet per minute. This, with 10ft. head, would give 28 h.p. The water in the river had fallen considerably between 11 and 12 o'clock, which would no doubt account for the difference in the two gaugings. The Bark Mill would be of no use for the purpose intended, as it can only have the water when not required by the corn mill, and the present wheel is only 6 h.p. or 8 h.p. At Little Mill, by putting up a turbine, 25 h.p. in summer and 30 h.p. in winter might be got. From the above information, I think the paper mill is the most likely place, and could be fitted up at least cost." Messrs. Nicholson and Jennings, in reply to this, said the power was too near that required, 40 h.p., but the number of lamps might be reduced, each lamp taking 1 h.p. They added: "As long as you are sure of getting 40 actual horse-power, you would be quite safe. We would suggest your sending the particulars to Gilbert Gilkes and Co., late Williamson Bros., Canal Iron Works, Kendal. They have had very considerable experience in this class of work, and have put up some very efficient low-fall turbines, and will be only too glad to give you an opinion, and if necessary the price of a turbine." The following, from a letter from the Keswick Electric Lighting Company, was also read: "The electric light is used in private houses, shops, and hotels, and is found quite satisfactory. The power is acquired by a Victor turbine, with 20ft. head of water giving 50 h.p., and steam power 50 h.p. in case of water running low either in dry or frosty weather. In front of the Keswick Hotel there is an arc lamp of 1,000 c.p., which is calculated to take 1 h.p. to supply. The front space has occasionally been used for a night drill of the volunteers." A committee was appointed to consider this correspondence, with power to call in professional assistance if necessary.

Liege University.—It is a curious fact, says the Paris correspondent of the *Standard*, that one of the first schools for teaching the science and applications of electricity to industry was opened at the University of Liège, the town to which the poor joiner's lad Gramme, born in 1826, at Jehay Bodegnée, Belgium, came to work, and at the same time to study geometry and mathematics at the free classes for adults. Had it not been for the knowledge he thus acquired at Liège, he would never have been able to understand the theories of the Italian *savant* Paccinotti, and to apply them in an invention which has made his name celebrated in every civilised country. One of the first schools of electricity was opened in 1883 at the same university. The initiative in this creation was taken by M. Montefiore-Levi, the Belgian senator and philanthropist, who is almost as well known throughout Europe and America as in his own country. In endowing the University of Liège with an electro-technical section, M. Montefiore-Levi had the double object in view of opening up a new and lucrative career to the students of the university where he himself had been educated, and of encouraging the electrical industries by facilitating the recruiting of their *personnel*, who require to have a thorough technical knowledge of electricity. He commenced by placing a sum of 100,000f. at the disposal of the Government for the preliminary cost of the purchase of the necessary instruments and materials, but since then he has gone on giving annually larger amounts, in proportion as the needs of the new school grew with its rapid development. The Government, on its side, furnished the buildings, but as the University of Liège was being rebuilt the electrical section was at first housed in modern constructions in the courtyard of the main buildings. This year it has been allotted a thoroughly appropriate building, containing workshops and laboratories. It is, indeed, so spacious that it has been possible to provide a separate laboratory for every two students of electricity. On this occasion M. Montefiore-Levi has given 150,000f. to provide the workshops and laboratories with all the necessary instruments and materials to enable students to make, not only the experiments requisite for their studies, but also experiments for new discoveries and inventions. The practical utility of the institution has been already amply demonstrated. All the students who have in any way distinguished themselves at it are sought after by the chiefs of the electrical industry. It would also be easy to give a long list of the useful inventions made by former pupils; but as imitation constitutes the most valuable praise, it will suffice to note that the Italian Government has followed the example set at Liège by creating a similar electrical school at the University of Milan, and by placing Signor Zurini, one of the former students of the Liège school, at its head. But though the electrical section of the Liège University owes its existence to M. Montefiore-Levi, its success and rapid development have been due to the untiring exertions of Prof. Eric Gérard, who has presided over it ever since it was created. M. Eric Gérard is a distinguished electrician, well known throughout Europe as having been the delegate of the Belgian Government at almost all the electrical congresses that have been held for many years past. He is a comparatively young man, having been born at Liège in 1856. When 22 years of age, he left the University of Liège and completed his electrical studies at the Belgian Ecole Supérieure de Télégraphie. M. Gérard has also written largely on electrical science.

ON A TEST OF EWING AND MACGREGOR'S METHOD OF MEASURING THE ELECTRICAL RESISTANCE OF ELECTROLYTES.[*]

BY PROF. J. G. MACGREGOR, D.SC., DALHOUSIE COLLEGE, HALIFAX, N.S.

(Concluded from page 152.)

To test the method described, I have compared the results it gives for the resistance of a tube containing zinc sulphate solution, with the results obtained by connecting up the tube as one of the arms of the bridge by means of amalgamated zinc electrodes and using the ordinary bridge method. As in this particular case there is no polarisation, and the measurement may be made as exactly as in the case of a metallic conductor, such a comparison forms a rigorous test of the reliability of the method under consideration.

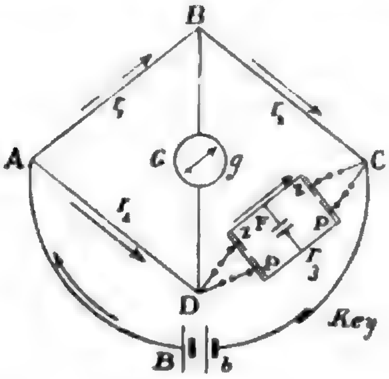

FIG. 1.

The electrolytic cell (F, in Fig. 1) which I used, consisted of a box formed of strips of window glass cemented together with marine glue. Its length was about 16 cm., breadth about 10 cm., and depth about 5 cm. It was divided traversely into two compartments of equal length by a glass partition cemented so as to be water-tight. Through the centre of this partition passed a tube whose length was different in different experiments. It was cemented at right angles to the partition, and its ends were open. At each end of the box were two electrodes, one of platinum (P) and one of zinc (Z), side by side, but not in contact. They were square with narrow strips projecting above the upper edge of the ends of the box. They were of approximately equal area, having edges about 4·5 cm. in length. Wires passed from the upper ends of the strips to brass binding screws fixed in and supported by blocks of solid paraffin. The wires from the zinc electrodes were of copper and had been soldered to the zinc without the use of acid. Those from the platinum electrodes were of platinum and had been welded to the electrodes. In both cases the wires were so thick that their resistance relatively to that of the electrolytic cell was small and might be neglected. From the binding screws thick copper wires passed to mercury pools in blocks of solid paraffin. From contiguous pools other wires passed to the ends C and D of the arms B C and A D of the bridge; and by connecting the proper pools by means of wires, the electrolytic cell might be joined up as an arm of the bridge either by means of the platinum or of the zinc electrodes.

The electrodes were in all cases placed as close as possible to the ends of the box. I did not attempt to place them at exactly the same distance, but satisfied myself by preliminary experiments that slight differences in the placing of the electrodes made no appreciable difference in the resistance of the cell.

With this cell (1) it was the same mass of liquid whose resistance was measured, whether the platinum or the zinc electrodes were used to connect it with the other arms of the bridge, and (2) there being a large mass of liquid in the cell, the tube being in the centre of this mass of liquid, the time intervening between the completion of a measurement of the resistance when the platinum electrodes were used and the completion of a measurement made with the zinc electrodes being a small fraction of a minute, and the cell being approximately at the temperature of the laboratory, the temperature of the tube must have been practically the same at the times of both measurements.

The only available box of resistance coils was a small one made by Stoehrer, of Leipzig. The coils were arranged so as to form three arms of a Wheatstone's bridge. Two of them contained two coils each of 100 and 10 Siemens units respectively. The third contained a number of coils ranging from 500 to 1 Siemens units.

I had no galvanometer well adapted to the experiments. I therefore extemporised one by combining the core of one Thomson's dead beat galvanometers (made by Elliott) with a pair of coils from a Wiedemann's galvanometer (made by Stoehrer). Both these coils were differentially wound; and thus I could vary the resistance of the galvanometer by combining them in different ways. Nevertheless, I was not in any case able to give the galvanometer the resistance which it ought to have had to attain the maximum sensitiveness in the bridge. The lightest mirror which was available weighed, with the magnet attached, about 0·06 gramme, just about twice as much as that used by Mr. Ewing and myself in our experiments. The diameter of the mirror was about 9 mm. My extemporised galvanometer had another defect—viz., that the inner windings of the coils were about 4 cm. from the magnet.

In making observations by the two methods, I in all cases first used the method under test, the cell being connected with the other arms of the bridge by means of the platinum electrodes, and immediately afterwards I determined the resistance with the cell connected up by means of the zinc electrodes. In this way I avoided bias.

I varied the resistance of the cell by changing the strength of the solution, or by introducing short glass rods into the tube, or by using tubes of different lengths. The resistance of the cell was in these ways made to vary from about 100 to about 4,000 Siemens units.

It would be useless to give the values of the resistance which the cell was found to have in the different observations made, as these values have no permanent importance. The general results were as follows:

1. As was to be expected, the resistance was almost invariably found to be greater when determined by the method under test than when determined by the other method.

2. When the resistance of the electrolytic cell was great say from 3,000 to 4,000 units, its value as determined by our method differed from its true value, as given by the use of the amalgamated zinc electrodes, by from 0·1 to 0·4 per cent. There was rarely so great a difference as 0·4 per cent., and in many cases the differences were less than 0·1 per cent. When, however, the resistance of the cell was small, say from 100 to 200 units, the differences were much larger, amounting even in some cases to 6 and 7 per cent. This unsatisfactory result, however, was clearly due to the fact that my box of resistance coils was so small that when the electrolytic cell had a small resistance I could not sufficiently reduce the current flowing through it without so increasing the resistance of the battery as to diminish seriously the sensitiveness of the bridge. The best test of the method under consideration, therefore, is given by the observations above referred to, with the cell so constructed as to have a high resistance. The agreement of these observationss seems to me to be very satisfactory, especially when we consider that, as pointed out above, the galvanometer with which the observations were made was so seriously defective. With a galvanometer of proper construction,[*] the error would undoubtedly be reduced to a still smaller magnitude. It requires to be reduced only to 0·054 per cent. to become as small as the difference found by Kohlrausch and Grotrian[†] between the resistance of a tube of zinc sulphate solution as determined by their admittedly satisfactory method and as determined by the use of amalgamated zinc electrodes.

I think, therefore, we may conclude that the galvanometer has already been constructed by the aid of which the method under consideration may be applied to give very accurate determinations of the resistance of electrolytes, and that in cases in which such a galvanometer is available, this method combines exactness of results with simplicity of apparatus in a very high degree.

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[*] A paper read before the Royal Society, Canada.

[*] Magnet-mirrors are now made I believe with moments of inertia of only $6 \cdot 10^{-6}$ C.G.S. units. The one I used had a moment of inertia of $2400 \cdot 10^{-6}$ C.G.S. units.

[†] "Pogg. Ann.," Bd. cliv. (1875), p. 10.

UNDERGROUND LIGHTING MAINS IN PARIS.*

BY E. DIEUDONNÉ.

(Continued from page 158.)

We will begin first with the conduits. The principle upon which they are laid has been defined at the beginning of this article. Before the laying of the cables, the Paris authorities lay down the special conditions under which the opening up of the trenches must be carried out—the depth and width and distance from the walls of the houses.

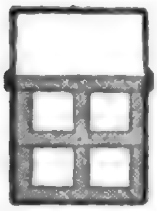
FIG. 4.

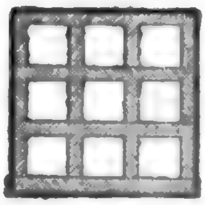
FIG. 6.

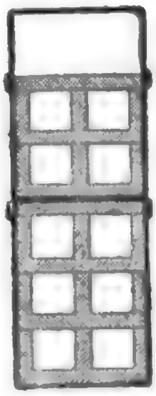
FIG. 5.

In the system adopted by the Compagnie de l'Air Comprimé, the protecting conduit of the mains is of cast iron, and made in two pieces, constituting a continuous conduit by means of lengths of about one yard laid end to end—the lower part is U-shaped, covered with a rounded or flat lid. These conduits are of varied dimensions, to receive a greater or less number of cables, as shown in Figs. 4 to 7, which are to the scale of one-tenth full size.

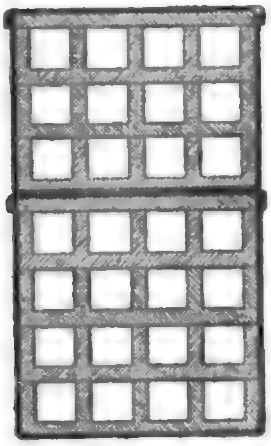
FIG. 7.

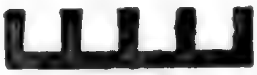
FIG. 8.

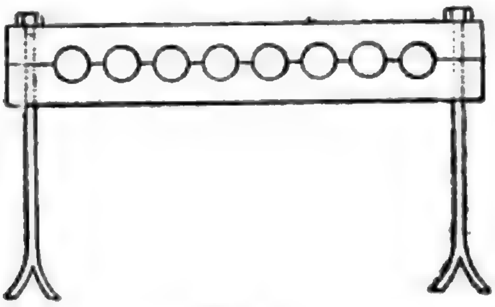
FIG. 9.

According to needs the conduits are superposed one upon the other in the same trench, on condition that the level of the upper one does not come nearer than half a metre to the surface of the soil.

The insulated cables do not rest directly upon the metallic surface of the conduit, but upon wooden supports impregnated with paraffin wax, dividing the conduit into a certain number of separate passages. The impregnation by paraffin wax, obtained by immersion in a bath of the melted wax, is for the purpose of guarding against destructive agencies within the soil, at the same time favouring the easy sliding of the cables during the drawing-in operations.

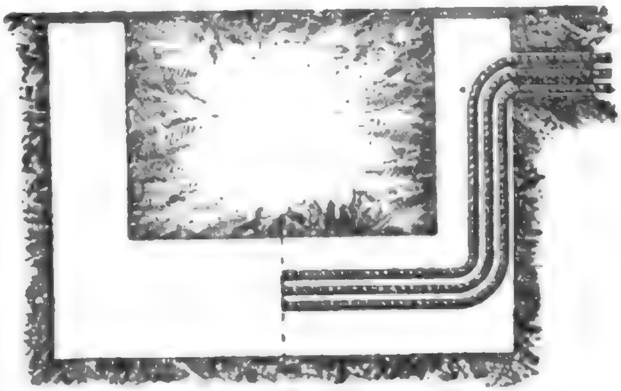
FIG. 10.

Fig. 8 shows a section of the profile of the shaped wood; Fig. 9 represents a model of the kind of support used in tunnels and manholes.

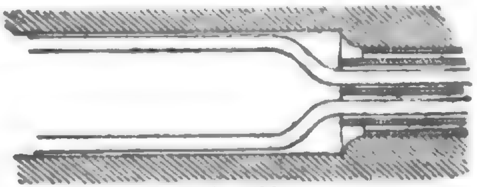
FIG. 11.

When crossing the streets the trenches, terminated at the manholes, are covered in, connected under the roadway by a horizontal gallery, and at the level of the pavement by iron covers. The depth of these pits varies from two to 10 yards, determined by the existence and relative position of drains and water or gas pipes beneath the street.

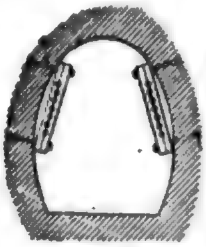
FIG. 12.

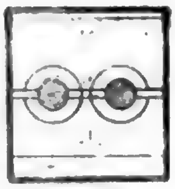
FIG. 13.

Issuing from the cast-iron conduits, the cables are taken down into the pits—positives to one side and negatives to the other—carried at a distance from the sides by clamps of paraffined wood, similar to those in Fig. 9, attached to arms fastened on the brickwork. After entering the gallery they are arranged in the same manner upon the inside surface of the vault (Figs. 10 to 12). The cables are firmly fastened by screws in the clamps, the clamps being constructed to carry from three to 16 cables.

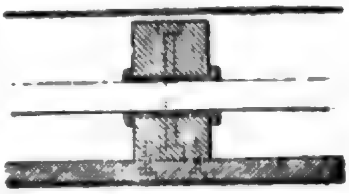
FIG. 14.

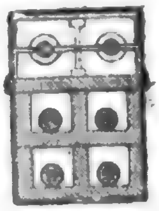
FIG. 17.

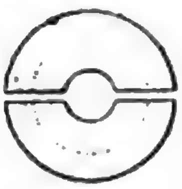
FIG. 15.

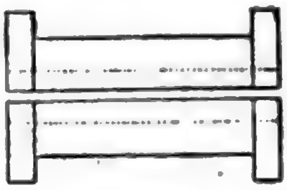
FIG. 16.

The method of laying bare cables differs from that just explained. These are always placed within cast-iron conduits. Sometimes they are laid together with feeders in the same passage way. The bottom of the conduit is furnished with a paraffined deal plank, upon which are bolted at intervals of 3ft. to 6ft. oak carriers in two pieces, whose length is equal to the transverse section of the conduit (Figs. 13 and 14). Porcelain insulators (Figs. 15 and 16) are fixed in these oak pieces, and through these are drawn the bare cables. In the cases where high-tension cables are present in the same conduit, these are placed below directly upon the wood plank, and the others are placed above, Fig. 17.

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* From *L'Electricien.*

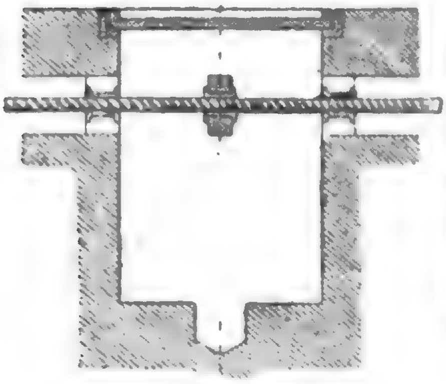

Fig. 18.

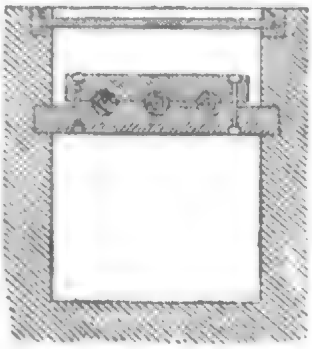

Fig. 19.

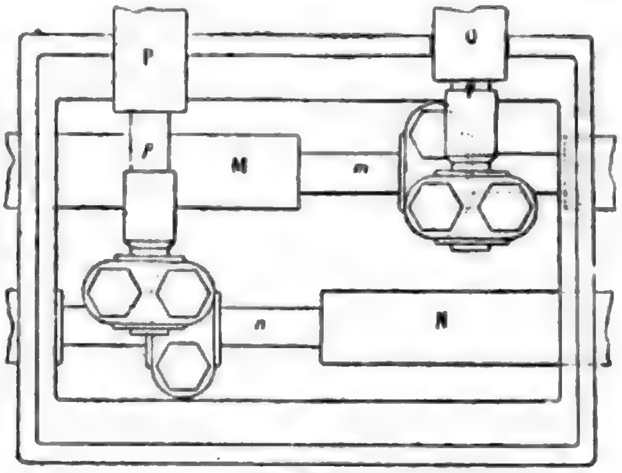

Fig. 21.

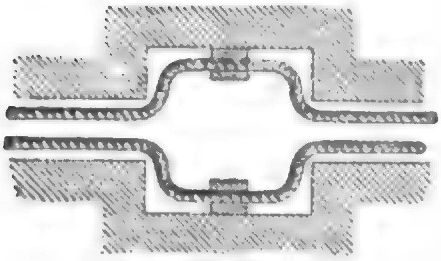

Fig. 20.

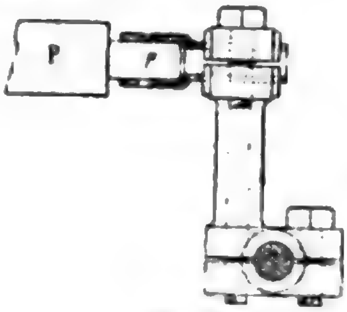

Fig. 22.

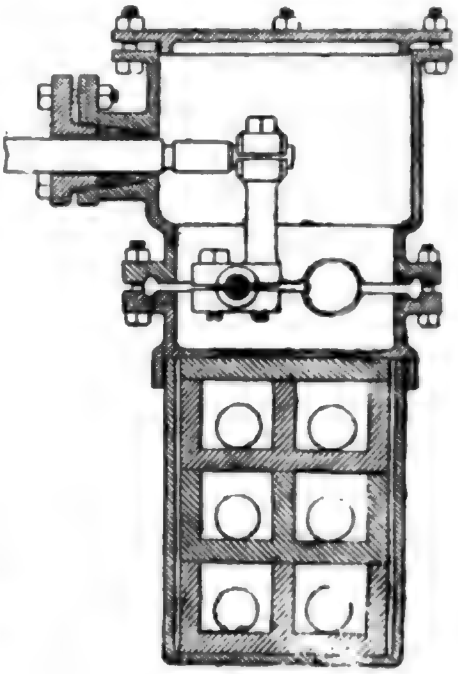

Fig. 25.

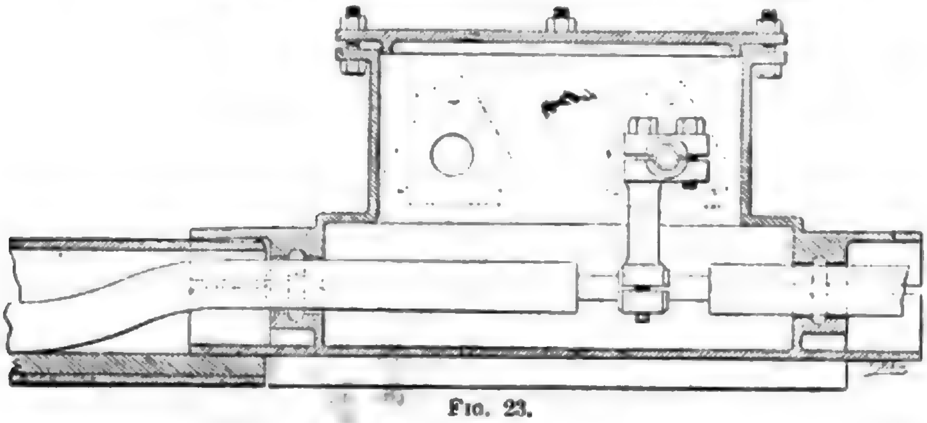

Fig. 23.

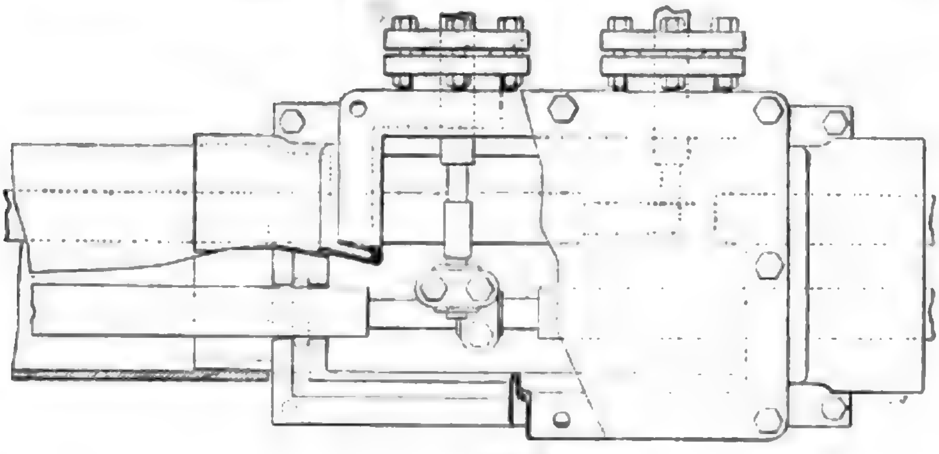

Fig. 24.

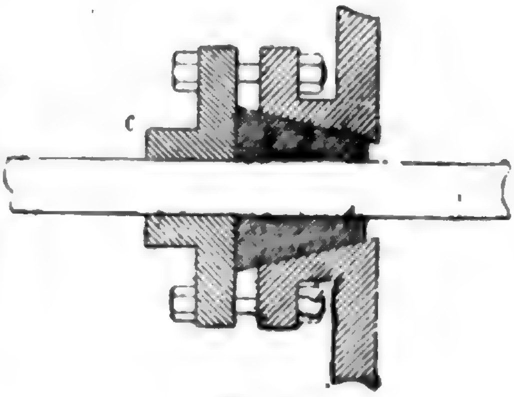

Fig. 26.

The proper inspection of the lines thus laid is arranged for by a series of inspection-boxes placed along the streets at distances of about 35 yards. Figs. 18 to 20 represent respectively the longitudinal and transverse sections and the plan of these inspection boxes, showing the arrangement of the cables passing through them. These are nothing but square pits of small dimensions, communicating with the conduits, and covered in with a cast-iron lid, generally filled in above with asphalte. The cables follow the contour of the walls, carried by paraffined wood supports. The diagrams herewith sufficiently explain the arrangement.

In the installation of any system of underground mains, be it for water, gas, compressed fluids, or of electricity, certain circumstances supervene, often inconveniently, which contribute to the difficulties of laying, and eventually influence in an undesirable manner the efficiency of a central system.

The experience gained with underground mains is as yet of too short duration to render it prudent to pronounce with any show of authority upon the value of one or of another system. We are reduced to conjectures. However this may be, there is one point upon which everybody is agreed, the difficulty which surrounds the perfect taking off the current. This is one of the most delicate of all the perations to be carried out on a central distributing system. t the places where the cables from the customers' houses re joined to the distributing mains it is usual to enclose he junctions within cast-iron chambers, termed service-oxes.

Figs. 21 and 22 allow the operations to be understood. he connection between two cables is made by a piece of opper (Fig. 22) having two collars between two clamps, of hich the extremities of the cables to be connected are ripped by means of two bolts or screws. The conductors, I and N, which it is desired to attach to the branches, P nd Q, are bared for a short length, *m*, *n*, *p*, and *q*. These arts are gripped by the connectors and screwed up tightly, fter which an insulating substance is poured in, filling p the lower part of the cast-iron box—which, in most ases, is in two parts—and then the whole chamber is closed y a screw-down lid.

The service mains coming laterally from the box pass hrough a sort of stuffing-box (Fig. 26). In this latter gure, the lateral wall is represented at A; a truncated pening is formed therein, into which is introduced an india-ubber plug, B, compressed by a screw-plate, C.

Figs. 23 to 26 show the various forms of boxes, the contruction of which is all upon the same principle. Every recaution is taken to ensure perfect watertightness in all he different parts.

(To be continued.)

EXPERIMENTS WITH ALTERNATE CURRENTS OF VERY HIGH FREQUENCY AND THEIR APPLICATION TO METHODS OF ARTIFICIAL ILLUMINATION.*

BY NIKOLA TESLA.

(Concluded from page 161).

The ideal way of lighting a hall or room, would, however, be to produce such a condition in it that an illuminating device could be moved and put anywhere, and that it is lighted, no matter where it is put, and without being electrically connected to anything. I have been able to produce such a condition by creating in the room a powerful, rapidly alternating electrostatic field. For this purpose I suspend a sheet of metal a distance from the ceiling on insulating cords and connect it to one terminal of the induction coil, the other terminal being preferably connected to the ground. Or else I suspend two sheets as illustrated in Fig. 30, each sheet being connected with one of the terminals of the coil, and their size being carefully determined. An exhausted tube may then be carried in the hand anywhere between the sheets or placed anywhere, even a certain distance beyond them; it remains always luminous.

In such an electrostatic field interesting phenomena may be observed, especially if the alternations are kept low and the potentials excessively high. In addition to the luminous phenomena mentioned, one may observe that any insulated conductor gives sparks when the hand or another object is approached to it, and the sparks may often be powerful. When a large conducting object is fastened on an insulating support, and the hand approached to it, a vibration, due to the rythmical motion of the air molecules, is felt, and luminous streams may be perceived when the hand is held near a pointed projection. When a telephone receiver is made to touch with one or both of its terminals an insulated conductor of some size, the telephone emits a loud sound; it also emits a sound when a length of wire is attached to one or both terminals, and with very powerful fields a sound may be perceived even without any wire.

How far this principle is capable of practical application the future will tell. It might be thought that electrostatic effects are unsuited for such action at a distance. Electromagnetic inductive effects, if available for the production of light, might be thought better suited. It is true the electrostatic effects diminish nearly with the cube of the distance from the coil, whereas the electromagnetic inductive effects diminish simply with the distance. But when we establish an electrostatic field of force, the condition is very different, for then, instead of the differential effect of both the terminals, we get their cojoint effect. Besides, I would call attention to the fact, that in an alternating electrostatic field, a conductor, such as an exhausted tube for instance, tends to take up most of the energy, whereas, in an an electromagnetic alternating field the conductor tends to take up the least energy, the waves being reflected with but little loss. This is one reason why it is difficult to excite an exhausted tube, at a distance, by electromagnetic induction. I have wound coils of very large diameter and of many turns of wire, and connected a Geissler tube to the ends of the coil with the object of exciting the tube at a distance; but even with the powerful inductive effects producible by Leyden jar discharges, the tube could not be excited unless at a very small distance, although some judgment was used as to the dimensions of the coil. I have also found that even the most powerful Leyden jar discharges are capable of exciting only feeble luminous effects in a closed exhausted tube, and even these effects upon thorough examination I have been forced to consider of an electrostatic nature.

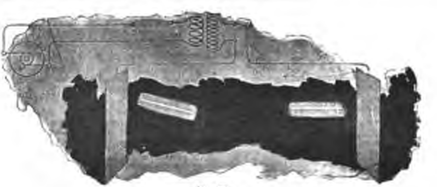

Fig. 30.

How, then, can we hope to produce the required effects at a distance by means of electromagnetic action, when even in the closest proximity to the source of disturbance, under the most advantageous conditions, we can excite but faint luminosity? It is true that when acting at a distance we have the resonance to help us out. We can connect an exhausted tube, or whatever the illuminating device may be, with an insulated system of the proper capacity, and so it may be possible to increase the effect qualitatively, and only qualitatively, for we would not get more energy through the device. So we may by resonance effect obtain the required E.M.F. in an exhausted tube, and excite faint luminous effects, but we cannot get enough energy to render the light practically available, and a simple calculation, based on experimental results, shows that even if all the energy which a tube would receive at a certain distance from the source should be wholly converted into light, it would hardly satisfy the practical requirements. Hence the necessity of directing, by means of a conducting circuit, the energy to the place of transformation. But in so doing we cannot very sensibly depart from present methods, and all we could do would be to improve the apparatus.

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* Lecture delivered before the American Institute of Electrical Engineers at Columbia College, New York, May 20.

From these considerations it would seem that if this ideal way of lighting is to be rendered practicable it will be only by the use of electrostatic effects. In such a case the most powerful electrostatic inductive effects are needed; the apparatus employed must, therefore, be capable of producing high electrostatic potentials changing in value with extreme rapidity. High frequencies are especially wanted, for practical considerations make it desirable to keep down the potential. By the employment of machines, or, generally speaking, of any mechanical apparatus, but low frequencies can be reached; recourse must, therefore, be had to some other means. The discharge of a condenser affords us a means of obtaining frequencies by far higher than are obtainable mechanically, and I have accordingly employed condensers in the experiments to the above end.

When the terminals of a high tension induction coil, Fig. 31, are connected to a Leyden jar, and the latter is discharging disruptively into a circuit, we may look upon the arc playing between the knobs as being a source of alternating, or generally speaking, undulating currents, and then we have to deal with the familiar system of a generator of such currents, a circuit connected to it, and a condenser bridging the circuit. The condenser in such case is a veritable transformer, and since the frequency is excessive, almost any ratio in the strength of the currents in both the branches may be obtained. In reality, the analogy is not quite complete, for in the disruptive discharge we have most generally a fundamental instantaneous variation of comparatively low frequency, and a superimposed harmonic vibration, and the laws governing the flow of currents are not the same for both.

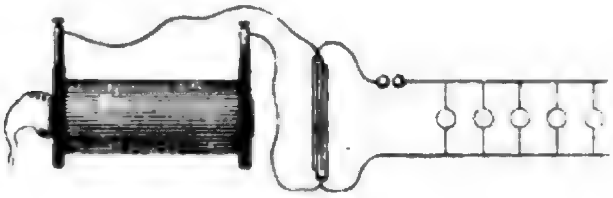

Fig. 31.

In converting in this manner, the ratio of conversion should not be too great, for the loss in the arc between the knobs increases with the square of the current, and if the jar be discharged through very thick and short conductors, with the view of obtaining a very rapid oscillation, a very considerable portion of the energy stored is lost. On the other hand, too small ratios are not practicable for many obvious reasons.

As the converted currents flow in a practically closed circuit, the electrostatic effects are necessarily small, and I therefore convert them into currents or effects of the required character. I have effected such conversions in several ways. The preferred plan of connections is illustrated in Fig. 32. The manner of operating renders it easy to obtain by means of a small and inexpensive apparatus enormous differences of potential which have been usually obtained by means of large and expensive coils. For this it is only necessary to take an ordinary small coil, adjust to it a condenser and discharging circuit, forming the primary of an auxiliary small coil, and convert upward. As the inductive effect of the primary currents is excessively great, the second coil need have comparatively but very few turns. By properly adjusting the elements remarkable results may be secured.

In endeavouring to obtain the required electrostatic effects in this manner, I have, as might be expected, encountered many difficulties which I have been gradually overcoming, but I am not as yet prepared to dwell upon my experiences in this direction.

I believe that the disruptive discharge of a condenser will play an important part in the future, for it offers vast possibilities, not only in the way of producing light in a more efficient manner and in the line indicated by theory, but also in many other respects.

For years the efforts of inventors have been directed towards obtaining electrical energy from heat by means of the thermopile. It might seem invidious to remark that but few know what is the real trouble with the thermopile. It is not the inefficiency or small output—though these are great drawbacks—but the fact that the thermopile has its phylloxera—that is, that by constant use it is deteriorated, which has thus far prevented its introduction on an industrial scale. Now that all modern research seems to point with certainty to the use of electricity of excessively high tension, the question must present itself to many whether it is not possible to obtain in a practicable manner this form of energy from heat. We have been used to look upon an electrostatic machine as a plaything, and somehow we couple with it the idea of the inefficient and impractical. But now we must think differently, for now we know that everywhere we have to deal with the same forces, and that it is a mere question of inventing proper methods or apparatus for rendering them available.

In the present systems of electrical distribution, the employment of the iron with its wonderful magnetic properties allows us to reduce considerably the size of the apparatus; but, in spite of this, it is still very cumbersome. The more we progress in the study of electric and magnetic phenomena, the more we become convinced that the present methods will be short-lived. For the production of light, at least, such heavy machinery would seem to be unnecessary. The energy required is very small, and if light can be obtained as efficiently as, theoretically, it appears possible, the apparatus need have but a very small output. There being a strong probability that the illuminating methods of the future will involve the use of very high potentials, it seems very desirable to perfect a contrivance capable of converting the energy of heat into energy of the requisite form. Nothing to speak of has been done towards this end, for the thought that electricity of some 50,000 or 100,000 volts pressure or more, even if obtained, would be unavailable for practical purposes, has deterred inventors from working in this direction.

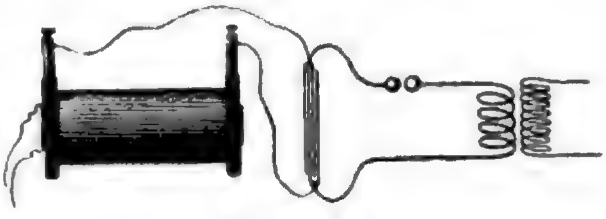

Fig. 32.

In Fig. 31 a plan of connections is shown for converting currents of high, into currents of low, tension by means of the disruptive discharge of a condenser. This plan has been used by me frequently for operating a few incandescent lamps required in the laboratory. Some difficulties have been encountered in the arc of the discharge which I have been able to overcome to a great extent; besides this, and the adjustment necessary for the proper working, no other difficulties have been met with, and it was easy to operate ordinary lamps, and even motors, in this manner. The line being connected to the ground, all the wires could be handled with perfect impunity, no matter how high the potential at the terminals of the condenser. In these experiments a high-tension induction coil, operated from a battery or from an alternate-current machine, was employed to charge the condenser; but the induction coil might be replaced by an apparatus of a different kind, capable of giving electricity of such high tension. In this manner, direct or alternating currents may be converted, and in both cases the current-impulses may be of any desired frequency. When the currents charging the condenser are of the same direction, and it is desired that the converted currents should also be of one direction, the resistance of the discharging circuit should, of course, be so chosen that there are no oscillations.

In operating devices on the above plan, I have observed curious phenomena of impedance which are of interest. For instance, if a thick copper bar be bent, as indicated in

Fig. 33, and shunted by ordinary incandescent lamps, then, by passing the discharge between the knobs, the lamps may be brought to incandescence although they are short-circuited. When a large induction coil is employed it is easy to obtain nodes on the bar, which are rendered evident by the different degree of brilliancy of the lamps, as shown roughly in Fig. 33. The nodes are never clearly defined, but there are simply maxima and minima of potentials along the bar. This is probably due to the irregularity of the arc between the knobs. In general when the above described plan of conversion from high to low tension is used, the behaviour of the disruptive discharge may be closely studied. The nodes may also be investigated by means of an ordinary Cardew voltmeter which should be well insulated. Geissler tubes may also be lighted across the points of the bent bar; in this case, of course, it is better to employ smaller capacities. I have found it practicable to light up in this manner a lamp, and even a Geissler tube, shunted by a short heavy block of metal, and this result seems at first very curious. In fact, the thicker the copper bar in Fig. 33, the better it is for the success of the experiments, as they appear more striking. When lamps with long slender filaments are used it will be often noted that the filaments are from time to time violently vibrated, the vibration being smallest at the nodal points. This vibration seems to be due to an electrostatic action between the filament and the glass of the bulb.

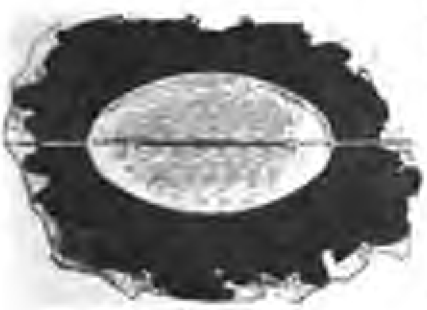

FIG. 34.

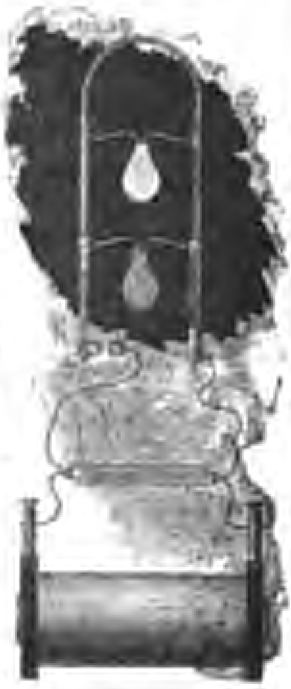

FIG. 33.

In some of the above experiments it is preferable to use special lamps having a straight filament, as shown in Fig 34. When such a lamp is used a still more curious phenomenon than those described may be observed. The lamp may be placed across the copper bar and lighted, and by using somewhat larger capacities, or, in other words, smaller frequencies, or smaller impulsive impedancies, the filament may be brought to any desired degree of incandescence. But when the impedance is increased a point is reached when comparatively little current passes through the carbon, and most of it through the rarified gas; or perhaps it may be more correct to state that the current divides nearly evenly through both, in spite of the enormous difference in the resistance, and this would be true unless the gas and the filament behave differently. It is then noted that the whole bulb is brilliantly illuminated, and the ends of the leading-in wires become incandescent and often throw off sparks in consequence of the violent bombardment, but the carbon filament remains dark. This is illustrated in Fig. 34. Instead of the filament a single wire extending through the the whole bulb may be used, and in this case the phenomenon would seem to be still more interesting.

From the above experiment it will be evident that when ordinary lamps are operated by the converted currents, those should be preferably taken in which the platinum wires are far apart, and the frequencies used should not be too great, else the discharge will occur at the ends of the filament or in the base of the lamp between the leading-in wires, and the lamp might then be damaged.

In presenting to you these results of my investigation on the subject under consideration, I have paid only a passing notice to facts upon which I could have dwelt at length, and among many observations I have selected only those which I thought most likely to interest you. The field is wide and completely unexplored, and at every step a new truth is gleaned, a novel fact observed.

How far the results here borne out are capable of practical applications will be decided in the future. As regards the production of light, some results already reached are encouraging, and make me confident in asserting that the practical solution of the problem lies in the direction I have endeavoured to indicate. Still, whatever may be the immediate outcome of these experiments, I am hopeful that they will only prove a step to further development towards the ideal and final perfection. The possibilities which are opened by modern research are so vast that even the most reserved must feel sanguine of the future. Eminent scientists consider the problem of utilising one kind of radiation without the others a rational one. In an apparatus designed for the production of light by conversion from any form of energy into that of light, such a result can never be reached, for no matter what the process of producing the required vibrations, be it electrical, chemical, or any other, it will not be possible to obtain the higher light vibrations without going through the lower heat vibrations. It is the problem of imparting to a body a certain velocity without passing through all lower velocities. But there is a possibility of obtaining energy not only in the form of light, but motive power, and energy of any other form, in some more direct way from the medium. The time will be when this will be accomplished, and the time has come when one may utter such words before an enlightened audience without being considered a visionary. We are whirling through endless space with an inconceivable speed, all around us everything is spinning, everything is moving, everywhere is energy. There must be some way of availing ourselves of this energy more directly. Then, with the light obtained from the medium, with the power derived from it, with every form of energy obtained without effort, from the store forever inexhaustible, humanity will advance with giant strides. The mere contemplation of these magnificent possibilities expands our minds, strengthens our hopes, and fills our hearts with supreme delight.

GODMANCHESTER.

The following comparative statement of the advantages and relative cost of electric light and gas from Messrs. Ernest Scott and Co., Newcastle-on-Tyne, was read by the clerk at the last meeting of the Godmanchester Town Council:

Electric light.—250 lamps of 16 c.p., 1,000 hours.

	£	s.	d.
Coal for 25 h.p., 1,000 hours, at 2½lb. per i.h.p. per hour, 28 tons at 8s.	11	4	0
Oil per week at 2s. 6d.	6	10	0
Sandries at 2s. 6d.	6	10	0
Lamp renewals, 250 lamps at 3s. 9d.	46	17	6
	71	1	6
Add 10 per cent. interest and depreciation on plant, say £400	40	0	0
	£111	1	6

Gas.—250 burners, 6ft. per hour, 1,000 hours.

	£	s.	d.
Cost of gas consumed, 1,500,000ft. at 2s. 6d. per 1,000ft.	187	10	0
Cost of replacing burners and repairs, 5s. per week	13	0	0
	200	10	0
Add 5 per cent. interest on capital expended on fittings, on say £150	7	10	0
	£208	0	0

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BRITISH ASSOCIATION—THE PRESIDENT'S ADDRESS.

As was to be expected, and as desirable, the presidential address to the Cardiff meeting of the British Association discourses mainly on astronomical questions. It is extremely interesting, however, to notice how interdependent are the various branches of science. Advance in one direction leads to advance in other directions. A new departure in photography means an extension of the range of astronomical research, for, as Dr. Huggins says, "The more recent discovery of the gelatine plate has given a further great impetus to this modern side of astronomy, and has opened a pathway into the unknown of which even an enthusiast 30 years ago would scarcely have dared to dream." That electrical research will play its part in astronomical matters is shadowed by such paragraphs in the address as that relating to the contention of Stas, who maintains "that electric spectra are to be regarded as distinct from flame spectra," although other observers do not agree with him. But, as Dr. Huggins says, "The presence of lines in the solar spectrum which we can only produce electrically is an indication of the high temperature of the sun." Advance in spectroscopy seems to be determined by advance into the regions of molecular physics. Hitherto many suggestions have been made, but real progress has in this domain been comparatively slow. In the early part of his address the president points out a real evil—in too hastily forming a conclusion—and states "the progress of science has been greatly retarded by resting important conclusions upon the apparent coincidence of single lines in spectroscopes of very small power." This danger is as great in other directions as in spectroscopy. A little examination of Dr. Huggins's address will show what a great part electricity is playing in all these investigations. He suggests the light of a comet is due to disruptive electric discharges, and that these discharges may be assisted and possibly increased by the action of the ultra-violet part of the sun's light. "Lenard and Wolf have shown that ultra-violet light can produce a discharge from a negatively electrified piece of metal, while Hallwachs and Righi have shown further that ultra-violet light can even charge positively an unelectrified piece of metal." Further, the suggestion that the sun's corona, as well as the tails of comets, is once more distinctly set forth as due to electricity, and "further, if such a force exist at the sun, the changes of terrestrial magnetism may be due to direct electric action, as the earth moves through lines of inductive force." No doubt Dr. Huggins has thoroughly convinced himself that such "lines of inductive force" do permeate space, although to the ordinary mind the "circuit" through which these lines must act is not easily traceable. Taking one hemisphere of the sun as the starting pole, where is the circuit by which the lines close again on the starting point? They certainly do not start from the sun and radiate into space. Many physicists look upon electricity as a radiant something; they cannot show one single experiment in support of their views, but always suppose something of the nature of an absurdity, in a pole being at an infinite distance from another pole—in fact, in such a position that no electrical phenomena could result. We are digressing, however, from the presidential address, which indicates not only the recent work done in celestial physics, but the vast amount of work still open to the earnest student, concluding with the pregnant statement that though the "pace of the race is gaining, 'the goal' is not and never will be in sight."

SECTION-PRESIDENTS: MATHEMATICAL—MECHANICAL.

Prof. Lodge, in his address to Section A, goes for a national laboratory. He does not believe much in individual or amateur efforts, but thinks scientific investigation should progress like an invading army. The rank and file require to be properly generalled and led. No doubt a national laboratory is theoretically a nice thing, especially for those who could pose as generals—give their orders, and see someone else do the work. The members of the younger generation would work hard; would move heaven and earth to obtain a chair in the laboratory. The nation is a good paymaster, but seldom a hard taskmaster. Who should decide as to the eligibility of candidates? And who should decide as to the value of the orders given and the work carried out? The real investigator is almost always working alone, along a new line, and time only can show the value of such work. Prof. Lodge says the question of a fifth or sixth decimal is very legitimate, and so it is; but it is of no earthly service to the nation as a nation, and national money ought not to be expended on such a pursuit. The President of Section G discourses upon mining operations, gives a good deal of information as to recent progress, and concludes that electrical apparatus "will eventually become the principal agent in underground mechanical operations."

TRANSMISSION OF POWER AT FRANKFORT.

We are advised that the plant for the transmission of power at Frankfort is now complete, and reports of the starting and tests are expected at once. The great feature of this enterprise is its entire novelty from two points—the transmission of large powers to such a long distance at enormous pressure, and the actual use of the rotary-current machines. The falls of the Neckar at Lauffen, in Wurtemberg, are at a distance of 180 kilometres, nearly 110 miles, from Frankfort. Over this distance three stout telegraph wires are carried on poles fitted with insulators furnished with oil insulation. The original poles first used at Oerlikon will be seen at the exhibition. Along these wires, electricity at a pressure of about 25,000 volts is to be transmitted in alternating currents whose phases or pulsations are so arranged as to overlap or interlink with each other, forming in the machine at the receiving end a rotating magnetic polarity by which the electric power can be converted into mechanical force and so distributed. The generator of this installation, which we shall illustrate next week, consists of a 300-h.p. dynamo of the new three-phase system, constructed by the Oerlikon Company, of Zurich, in conjunction with the Allgemeine Company, of Berlin. On August 15, the date fixed by contract, the apparatus was handed over to the Board of Management of the exhibition.

The conductors required for the transmission of the current have been run by the German Imperial Postal Administration, and the Royal Wurtemberg Telegraph Authorities. The machinery at Lauffen is already in working order, and next week the measurements and tests of strength prescribed by the Imperial and Wurtemberg Governments will take place. It is probable, therefore, that by the end of next week the transmission of electric force from Lauffen to Frankfort can be regularly begun. The power will be used as follows: Of the 300 h.p., more or less, that is received, 100 h.p. will be used to pump water to supply an enormous waterfall in the exhibition grounds, 100 h.p. will be used for lighting purposes, and the remainder will be distributed in power transmission. The experiment is attracting the keenest interest in scientific circles and practical circles, as it is abundantly felt that the practical demonstration of the utilisation of natural forces at such distances from the source, opens almost undreamt-of possibilities to industry in the future.

VIBRATIONS OF CONDUCTORS.

A thin metallic wire stretched between two supports, one of which is furnished with a tightening winch to regulate the tension, when traversed by a *continuous* current, begins to vibrate, says M. D. Hurmuzescu in *Comptes Rendus*. The amplitude of the vibrations, at first very feeble, gradually increases and rapidly attains a maximum, which is preserved as long as the current passes, provided that the surrounding conditions remain the same, or at least do not abruptly change. The vibrations may thus continue indefinitely; they cease in a few seconds when the current ceases.

For a determined electric pressure, the amplitude of the vibrations seem to depend (according to the experiments hitherto made) upon the difference of temperature of the wire and the surrounding medium. As this difference of temperature depends on the strength of current for the same wire, the phenomenon should vary with the strength of current.

The explanation seems to result from the exchange of heat between the wire and the surrounding medium, and constitutes a veritable "thermic motor," in which the energy expended is furnished by the current, and the principle of conservation of energy can be applied thereto.

Any cause which will change in any way the mode of this exchange will modify the phenomenon. More particularly, it can be foreseen that the finer the wire the more rapid will be the vibration, and this is confirmed by experiment. I have repeated the experiment with wires of different kinds, and have found that the vibrations always maintain the same character. If the wire is enclosed within a glass tube the vibrations are regular, as the wire is sheltered from movements of the air. Closing the two ends does not change the rapidity. I hope to present later the laws of the phenomenon with regard to the tension of the wire, the difference of temperatures between the wire and the surrounding medium, and the manner in which the exchange of heat is effected between the two sources.

EDISON DYNAMO AND MOTOR.

(Concluded from page 134.)

The steel armature shaft is $16\frac{1}{2}$in. long and $\frac{1}{2}$in. in diameter at the journals, and $\frac{11}{16}$in. in diameter between the journals. The larger part of the shaft is $9\frac{1}{2}$in. long. Sufficient end chase is allowed in the armature journals to cause the surfaces to wear smoothly.

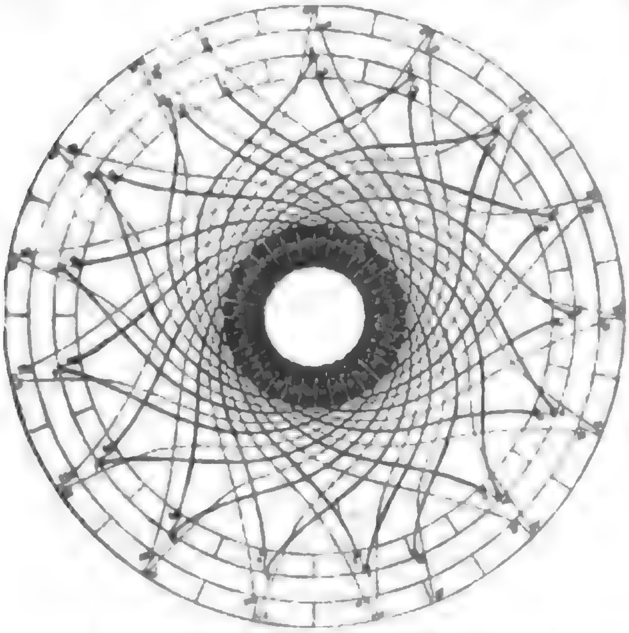

Fig. 1.—Diagram of Winding of Edison Armature.

On the central portion of the armature shaft is placed a wooden sleeve, $1\frac{1}{16}$in. in diameter; on this are mounted the thin sheet iron discs forming the armature core. These discs are $2\frac{1}{4}$in. in diameter. They are arranged in series of five, with tissue paper between the discs, and between the series of five are placed several thicknesses of paper. Enough discs are clamped together on the shaft to make this portion of the core $3\frac{1}{2}$in. long. The cast-iron discs, between which the sheet-iron discs are placed, are $\frac{1}{4}$in. in thickness and $2\frac{1}{8}$in. in diameter. One of them is fixed on the shaft, the other being held in place by a hexagonal nut screwed on the shaft. The cast-iron discs have their outer corners rounded, and in the edge of each are formed 32 equi-distant radial slits, $\frac{1}{32}$in. wide. In these slits are inserted slips of vulcanised fibre for separating the different pairs of coils during the operation of winding.

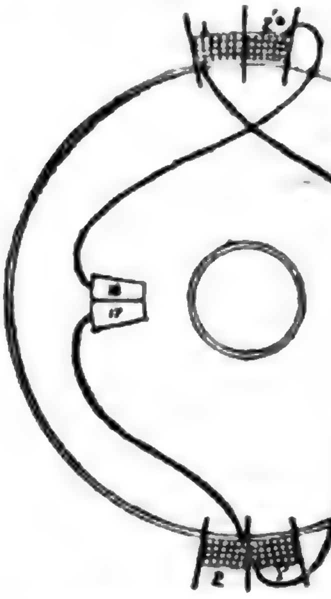

Fig. 2.—The First Two Coils and Commutator Connections.

It is impossible to describe the Edison winding without depending mainly on the diagrams, Figs. 1 and 2. There are two series of coils; that is to say, there are two coils in each division of the armature. There are 32 bars in the commutator, which are numbered consecutively from 1 to 32.

The armature core and shaft are thoroughly insulated by means of paper coated with an adhesive varnish. Jute string ribbon is wound on the face of the core as a further protection.

The wire used on the armature is No. 21 copper wire, double covered, the inner covering being of silk, the outer of cotton.

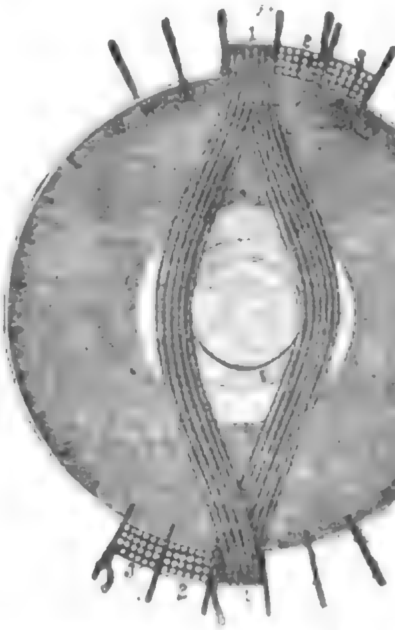

Fig. 3.—Arrangement of the Layers at End of Armature Core.

Leaving an end out for connection with the commutator coil, No. 1 is begun at 1 and wound in four layers, with six convolutions in each layer, the outer terminal coming at 1'. These ends are marked respectively 1 and 1' in such a manner as to avoid any possibility of the detachment of the marks. If this caution is observed, much trouble may be avoided. A good way to mark them is to place a tag of parchment, or parchment paper, on each end of the wire, with the number marked on.

After winding coil No. 1 the armature is turned half way over, and coil No. 2 is wound and marked in the same way, with 2 on the inner end of the coil and 2' on the outer end. The coil is then reversed and coil No. 3 is wound, and its ends are marked in the same way, and so on until the first series of coils is finished, the last coil of the series being marked 16 and 16'.

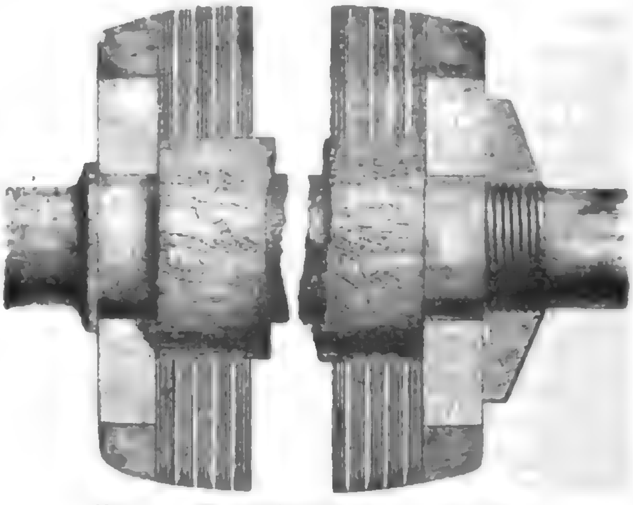

Fig. 4.—The Ends of the Armature Core.

The first coil of the outer series is No. 17-17'. This is wound on the top of coil No. 1. The armature is turned over, and No. 18 is wound on the top of No. 2, and so on until all of the outer coils are in place.

Before winding, the inner end of each wire is wrapped in jute string ribbon to a point within the end of the armature core, and it is further protected by a wrapping of thin adhesive tape. The outer end of the coil is covered in the same way.

About 3lb. of No. 21 wire are required for the armature. The length of wire in the first inner coil is 26ft. 6in. The length of wire in the last outer coil is 35ft.

The commutator cylinder is formed of 32 bronze bars having bevelled ends and radial arms for receiving the wires. These bars are clamped in position on a sleeve having an under-cut flange, by a countersunk washer and a nut screwed on the sleeve. Mica is inserted between the commutator bars, between the bars and the sleeve, and between the ends of the bars and the flange and the washer. The radial arms extending from the commutator bars each have a slot in the end for receiving the terminals of the coils.

The binding rings are formed of brass wire, wound tightly over a layer of mica interposed between the wire and the binding. The binding wire is secured by clips and soft soldering.

The brush yoke is provided with wooden handle by which it may be moved, and a binding screw by which it is clamped in the position of use. In mortises in the ends of the yoke are placed insulating blocks, in which are inserted the brush-holding studs. These studs are each provided with a nut for clamping the brush-holder cables which communicate with the leads at the side of the pole-pieces.

On each brush-holding stud is placed a sleeve fastened with a set screw, also a loose sleeve connected with the fast sleeve by a spiral spring concealed within it. The loose sleeve is furnished with a brush clamp for holding the brush, which bears on the commutator cylinder with a yielding pressure. The brushes are formed of spring copper wires fastened together at their outer ends with soft solder. A jig goes with each machine for clamping the brush and guiding the file while renewing the brush ends.

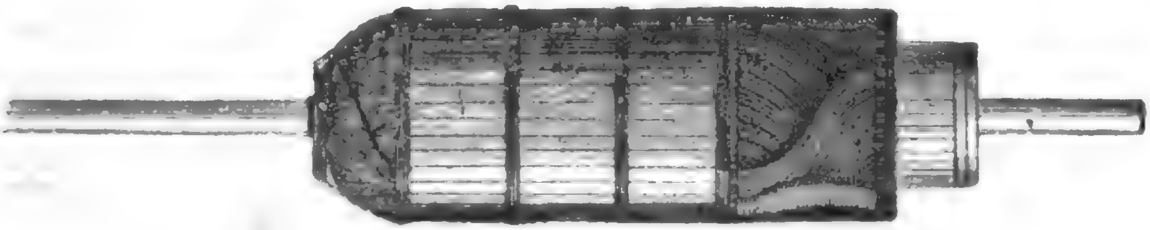

Fig. 5.—The Armature with Parts Broken away.

The coil terminals are arranged in groups of 16, the wires of each group being parallel. The terminals are carried around and attached to commutator bars, which are about 45deg. from the planes of the coils to which they belong, thus making the winding more symmetrical, and at the same time permitting of a better arrangement of the brushes

The coil terminals are inserted in the slots of the arms of the commutator bars, and soldered with soft solder, the connections being made in accordance with the diagram, Fig. 1.

The wires, where they cross at the back and front end of the armature, are separated by sheets of mica. Where the winding crosses at the rear end of the armature the wires are spread out so that they are only one layer deep.

When the winding of a coil is finished, the terminal is fastened by stout threads inserted in the coil before winding the last three convolutions, and tied after the coil is complete.

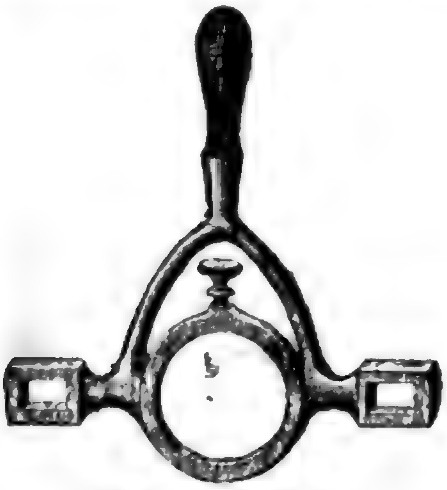

Fig. 6.—The Brush Yoke.

A vulcanised fibre collar, a little larger in diameter than the commutator, is slipped over the commutator bars and placed against the radial arms of the bars, as shown. The edge of the collar is grooved and a canvas cover is fastened to the collar by tying it in the groove. It is then drawn over the terminals and fastened by the first ring of binding wire on the armature. At the opposite end of the armature a similar collar and cover is provided.

Before covering the terminals with the canvas they are wound with twine, to give the end of the armature a symmetrical shape. The winding is varnished with shellac before its cover is applied, and the cover is varnished after it is secured in place.

The speed of the motor on a 125-volt circuit is 2,400 revolutions per minute. The speed at which the armature is to be driven in order to generate a current having an E.M.F. of 125 volts is 2,730 revolutions per minute.

Since the first part of this article appeared in our issue of July 25, we have received a letter from the Edison General Electric Company, stating that the machine here described—according to the new rating, which went into effect June 15—is a 0 5 kilowatt machine, which, when used as a generator, for supplying lights, will generate sufficient current to bring to full candle-power nine 16-c.p. 112-volt lamps, and when used for power it is a ½-h.p. motor at a rated volt. It is guaranteed to give 0·47 h.p. at ⅞ of its rated volts.

We are also reminded by this letter of the fact we neglected to state in our former article, which is that this form of machine is a type which was brought out in 1885, and is known as the Standard Edison machine, which is made in several sizes. Each size is identical, in its general construction, with the machine described, and any of the machines can be used either as dynamo or motor.—*Scientific American.*

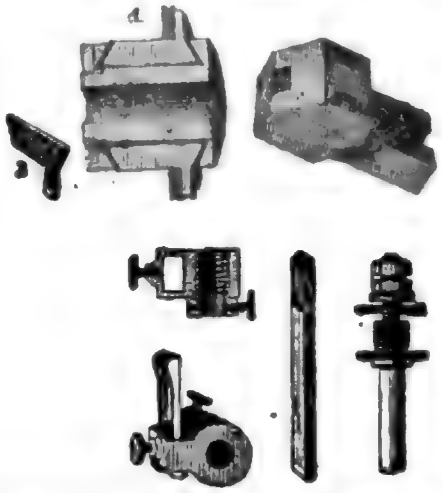

Fig. 7.—Details of Brush Holders and Commutator Cylinder.

The Hampstead Vestry has resolved to apply to the Board of Trade for a provisional order authorising it to introduce electric lighting for public and private uses in the borough of Hampstead. The Vestry has, however, not yet decided whether to carry out the lighting itself or to place it in the hands of an electrical company.

THE BRITISH ASSOCIATION AT CARDIFF.

The sixty-first meeting of the British Association for the Advancement of Science was opened at Cardiff on Wednesday night, when William Huggins, Esq., D.C.L., LL.D., etc., the president for the ensuing year, delivered his presidential address. Sir Frederick Abel, the past-president, first addressed some congratulatory remarks to the Marquis of Bute, who, in his capacity of mayor, welcomed the association to Cardiff. Dr. Huggins was then formally introduced, and was cordially greeted by a large and fashionable audience assembled to hear his presidential address on astronomical science. Amongst the audience were Prof. Max Müller, Sir Fred. Bramwell, Sir Douglas Galton, Sir Benj. Baker, most of the presidents of the sections, Prof. Newton, Mr. W. H. Preece, Prof. Rücker, and many other well-known scientific men.

PRESIDENTIAL ADDRESS BY WILLIAM HUGGINS, Esq., D.C.L. (Oxon.), LL.D. (Cantab., Edin., et Dublin.), Ph.D. (Lugd. Bat.), F.R.S., F.R.A.S., Hon. F.R.S.E., etc., Correspondant de l'Institut de France.

It is now many years since this association has done honour to the science of astronomy in the selection of its president.

Since Sir George Airy occupied the chair in 1851, and the late Lord Wrottesley nine years later in 1860, other sciences have been represented by the distinguished men who have presided over your meetings.

The very remarkable discoveries in our knowledge of the heavens which have taken place during this period of 30 years—one of amazing and ever-increasing activity in all branches of science—have not passed unnoticed in the addresses of your successive presidents; still, it seems to me fitting that I should speak to you to-night chiefly of those newer methods of astronomical research which has led to those discoveries, and which have become possible by the introduction since 1860 into the observatory of the spectroscope and the modern photographic plate.

In 1866 I had the honour of bringing before this association, at one of the evening lectures, an account of the first-fruits of the novel and unexpected advances in our knowledge of the celestial bodies which followed rapidly upon Kirchoff's original work on the solar spectrum and the interpretation of its lines.

Since that time a great harvest has been gathered in the same field by many reapers. Spectroscopic astronomy has become a distinct and acknowledged branch of the science, possessing a large literature of its own and observatories specially devoted to it. The more recent discovery of the gelatine dry plate has given a further great impetus to this modern side of astronomy, and has opened a pathway into the unknown of which even an enthusiast 30 years ago would scarcely have dared to dream.

In no science, perhaps, does the sober statement of the results which have been achieved appeal so strong to the imagination, and make so evident the almost boundless powers of the mind of man. By means of its light alone to analyse the chemical nature of a far distant body; to be able to reason about its present state in relation to the past and future; to measure within an English mile or less per second the otherwise invisible motion which it may have towards or from us; to do more, to make even that which is darkness to our eyes light, and from vibrations which our organs of sight are powerless to perceive to evolve a revelation in which we see mirrored some of the stages through which the stars may pass in their slow evolutional progress—surely the record of such achievements, however poor the form of words in which they may be described, is worthy to be regarded as the scientific epic of the present century.

I do not purpose to attempt a survey of the progress of spectroscopic astronomy from its birth at Heidelberg in 1859, but to point out what we do know at present, as distinguished from what we do not know, of a few only of its more important problems, giving a prominent place, in accordance with the traditions of this chair, to the work of the last year or two.

In the spectroscope itself advances have been made by Lord Rayleigh by his discussions of the theory of the instrument, and by Prof. Rowland in the construction of concave gratings.

Lord Rayleigh has shown that there is not the necessary connection, sometimes supposed, between dispersion and resolving power, as besides the prism, or grating, other details of construction and of adjustment of a spectroscope must be taken into account.

The resolving power of the prismatic spectroscope is proportional to the length of path in the dispersive medium. For the heavy flint glass used in Lord Rayleigh's experiments the thickness necessary to resolve the sodium lines came out 1·02 cm. If this be taken as a unit, the resolving power of a prism of similar glass will be in the neighbourhood of the sodium lines equal to the number of centimetres of its thickness. In other parts of the spectrum the resolving power will vary inversely as the third power of the wave-length, so that it will be eight times as great in the violet as in the red. The resolving power of a spectroscope is therefore proportional to the total thickness of the dispersive material in use, irrespective of the number, the angles, or the setting of the separate prisms into which, for the sake of convenience, it may be distributed.

The resolving power of a grating depends upon the total number of lines on its surface, and the order of spectrum in use; about 1,000 lines being necessary to resolve the sodium lines in the first spectrum.

As it is often of importance in the record of observations to state the efficiency of the spectroscope with which they were made, Prof. Schuster has proposed the use of a unit of purity as well as of resolving power, for the full resolving power of a spectroscope is realised in practice only when a sufficiently narrow slit is used. The unit of purity also is to stand for the separation of two lines differing by one-thousandth of their own wave-length—about the separation of the sodium pair at D.

A further limitation may come in from the physiological fact that, as Lord Rayleigh has pointed out, the eye when its full aperture is used is not a perfect instrument. If we wish to realise the full resolving power of a spectroscope, therefore, the emergent beam must not be larger than about one-third of the opening of the pupil.

Up to the present time the standard of reference for nearly all spectroscopic work continues to be Angstrom's map of the solar spectrum, and his scale based upon his original determinations of absolute wave-length. It is well known, as was pointed out by Thalén in his work on the spectrum of iron in 1884, that Angstrom's figures are slightly too small, in consequence of an error existing in a standard metre used by him. The corrections for this have been introduced into the tables of the wave-lengths of terrestrial spectra collected and revised by a committee of this association from 1885 to 1887. Last year the committee added a table of corrections to Rowland's scale.

The inconvenience caused by a change of standard scale is, for a time at least, considerable; but there is little doubt that in the near future Rowland's photographic map of the solar spectrum, and his scale based on the determinations of absolute wave-length by Pierce and Bell, or the Potsdam scale based on original determinations by Müller and Kempf, which differs very slightly from it, will come to be exclusively adopted.

The great accuracy of Rowland's photographic map is due chiefly to the introduction by him of concave gratings, and of a method for their use, by which the problem of the determination of relative wave-lengths is simplified to measures of coincidences of the lines in different spectra by a micrometer.

The concave grating and its peculiar mounting, in which no lenses or telescope are needed, and in which all the spectra are in focus together, formed a new departure of great importance in the measurement of spectral lines. The valuable method of photographic sensitisers for different parts of the spectrum has enabled Prof. Rowland to include in his map the whole visible solar spectrum, as well as the ultra-violet portion as far as it can get through our atmosphere. Some recent photographs of the solar spectrum, which include A, by Mr. George Higgs, are of great technical beauty.

During the past year the results of three independent researches have appeared, in which the special object of the observers has been to distinguish the lines which are due to our atmosphere from those which are truly solar—the maps of M. Thollon, which, owing to his lamented death just before their final completion, have assumed the character of a memorial of him, maps by Dr. Becker, and sets of photographs of a high and a low sun by Mr. McClean.

At the meeting of this association in Bath, M. Janssen gave an account of his own researches on the terrestrial lines of the solar spectrum, which owe their origin to the oxygen of our atmosphere. He discovered the remarkable fact that while one class of bands varies as the density of the gas, other diffuse bands vary as the square of the density. These observations are in accordance with the work of Egoroff and of Olszewski, and of Liveing and Dewar on condensed oxygen. In some recent experiments Olszewski, with a layer of liquid oxygen 30 millimetres thick, saw, as well as four other bands, the band coincident with Fraunhofer's A—a remarkable instance of the persistence of absorption through a great range of temperature. The light which passed through the liquid oxygen had a light blue colour resembling that of the sky.

Of not less interest are the experiments of Knut Angstrom, which show that the carbonic acid and aqueous vapour of the atmosphere reveal their presence by dark bands in the invisible infra-red region, at the positions of bands of emission of these substances.

It is now some 30 years since the spectroscope gave us for the first time certain knowledge of the nature of the heavenly bodies, and revealed the fundamental fact that terrestrial matter is not peculiar to the solar system, but is common to all the stars which are visible to us.

In the case of a star such as Capella, which has a spectrum almost identical with that of the sun, we feel justified in concluding that the matter of which it is built up is similar, and that its temperature is also high, and not very different from the solar temperature. The task of analysing the stars and nebulæ becomes, however, one of very great difficulty when we have to do with spectra differing from the solar type. We are thrown back upon the laboratory for the information necessary to enable us to interpret the indications of the spectroscope as to the chemical nature, the density and pressure, and the temperature of the celestial masses.

What the spectroscope immediately reveals to us are the waves which were set up in the ether filling all interstellar space, years or hundreds of years ago, by the motions of the molecules of the celestial substances. As a rule, it is only when a body is gaseous and sufficiently hot that the motions within its molecules can produce bright lines and a corresponding absorption. The spectra of the heavenly bodies are indeed to a great extent absorption spectra, but we have usually to study them through the corresponding emission spectra of bodies brought into the gaseous form and rendered luminous by means of flames or of electric discharges. In both cases, unfortunately, as has been shown recently by Profs. Liveing and Dewar, Wullner, E. Wiedemann, and others, there appears to be no certain direct relation between the luminous radiation as shown in the spectroscope and the temperature of the flame, or of the gaseous contents of the vacuum tube—that is, in the usual sense of the term as applied to the mean motion of all the molecules. In both cases, the vibratory motions within the molecules to which their luminosity is due are almost always much greater than would be produced by encounters of molecules having motions of translation no greater than the average motions which characterise the temperature of the gases as a whole. The temperature of the vacuum tube through which an electric discharge is taking place may be low, as shown by a thermometer, quite apart from the consideration of the extreme smallness of the mass of gas, but the vibrations of the luminous molecules must be violent in whatever way we suppose them to be set up by the discharge; if we take Schuster's view that comparatively few molecules are carrying the discharge, and that it is to the fierce encounters of these alone that the luminosity is due, then, if all the molecules had similar motions, the temperature of the gas would be very high.

So in flames where chemical changes are in progress, the vibratory motions of the molecules, which are luminous, may be, in connection with the energy set free in these changes, very different from those corresponding to the mean temperature of the flame.

Under the ordinary conditions of terrestrial experiments, therefore, the temperature or the mean *vis viva* of the molecules may have no direct relation to the total radiation, which, on the other hand, is the sum of the radiation due to each luminous molecule.

These phenomena have recently been discussed by Ebert from the standpoint of the electromagnetic theory of light.

Very great caution is therefore called for when we attempt to reason by the aid of laboratory experiments to the temperature of the heavenly bodies from the radiation, especially on the reasonable assumption that in them the luminosity is not ordinarily associated with chemical changes or with electrical discharges, but is due to a simple glowing from the ultimate conversion into molecular motion of the gravitational energy of shrinkage.

In a recent paper, Stas maintains that electric spectra are to be regarded as distinct from flame spectra; and, from researches of his own, that the pairs of lines of the sodium spectrum other than D are produced only by disruptive electric discharges. As these pairs of lines are found reversed in the solar spectrum, he concludes that the sun's radiation is due mainly to electric discharges. But Wolf and Diacon, and later, Watts, observed the other pairs of lines of the sodium spectrum when the vapour was raised above the ordinary temperature of the Bunsen flame. Recently, Liveing and Dewar saw easily, besides D, the citron and green pairs and sometimes the blue pair and the orange pair, when hydrogen charged with sodium vapour was burning at different pressures in oxygen. In the case of sodium vapour, therefore, and presumably in all other vapours and gases, it is a matter of indifference whether the necessary vibratory motion of the molecules is produced by electric discharges or by flames. The presence of lines in the solar spectrum, which we can only produce electrically, is an indication, however, as Stas points out, of the high temperature of the sun.

We must not forget that the light from the heavenly bodies may consist of the combined radiations of different layers of gas at different temperatures, and possibly be further complicated to an unknown extent by the absorption of cooler portions of gas outside.

Not less caution is needed if we endeavour to argue from the broadening of lines and the coming in of a continuous spectrum as to the relative pressure of the gas in the celestial atmospheres. On the one hand, it cannot be gainsaid that in the laboratory the widening of the lines in a Plucker's tube follows upon increasing the density of the residue of hydrogen in the tube, when the vibrations are more frequently disturbed by fresh encounters, and that a broadening of the sodium lines in a flame at ordinary pressure is produced by an increase of the quantity of sodium in the flame; but it is doubtful if pressure, as distinguished from quantity, does produce an increase of the breadth of the lines. An individual molecule of sodium will be sensibly in the same condition, considering the relatively enormous number of the molecules of the other gases, whether the flame is scantily or copiously fed with the sodium salt. With a small quantity of sodium vapour the intensity will be feeble except near the maximum of the lines; when, however, the quantity is increased the comparative transparency on the sides of the maximum will allow the light from the additional molecules met with in the path of the visual ray to strengthen the radiation of the molecules farther back, and so increase the breadth of the lines.

In a gaseous mixture it is found, as a rule, that at the same pressure or temperature, as the encounters with similar molecules become fewer, the spectral lines will be affected as if the body were observed under conditions of reduced quantity or temperature.

In their recent investigation of the spectroscopic behaviour of flames under various pressures up to 40 atmospheres, Profs. Liveing and Dewar have come to the conclusion that though the prominent feature of the light emitted by flames at high pressure appears to be a strong continuous spectrum, there is not the slightest indication that this continuous spectrum is produced by the broadening of the lines of the same gases at low pressure. On the contrary, photometric observations of the brightness of the continuous spectrum, as the pressure is varied, show that it is mainly produced by the mutual action of the molecules of a gas. Experiments on the sodium spectrum were carried up to a pressure of 40 atmospheres without producing any definite effect on the width of the lines which could be ascribed to the pressure. In a similar way the lines of the spectrum of water showed no signs of expansion up to 12 atmospheres; though more intense than at ordinary pressure, they remained narrow and clearly defined.

It follows, therefore, that a continuous spectrum cannot be considered, when taken alone, as a sure indication of matter in the liquid or the solid state. Not only, as in the experiments already mentioned, such a spectrum may be due to gas when under pressure, but, as Maxwell pointed out, if the thickness of a medium, such as sodium vapour, which radiates and absorbs different kinds of light, be very great, and the temperature high, the light emitted will be of exactly the same composition as that emitted by lampblack at the same temperature, for the radiations, which are feebly emitted, will be also feebly absorbed, and can reach the surface from immense depths. Schuster has shown that oxygen, even in a partially exhausted tube, can give a continuous spectrum when excited by a feeble electric discharge.

Compound bodies are usually distinguished by a banded spectrum; but, on the other hand, such a spectrum does not necessarily show the presence of compounds—that is, of molecules containing different kinds of atoms—but simply of a more complex molecule, which may be made up of similar atoms, and be therefore an allotropic condition of the same body. In some cases, for example, in the diffuse bands of the absorption spectrum of oxygen, the bands may have an intensity proportional to the square of the density of the gas, and may be due either to the formation of more complex molecules of the gas with increase of pressure, or it may be to the constraint to which the molecules are subject during their encounters with one another.

It may be thought that at least in the coincidences of bright lines we are on the solid ground of certainty, since the length of the waves set up in the ether by a molecule, say, of hydrogen, is the most fixed and absolutely permanent quantity in nature, and is so of physical necessity, for with any alteration the molecule would cease to be hydrogen.

Such would be the case if the coincidence were certain; but an absolute coincidence can be only a matter of greater or less probability, depending on the resolving power employed, on the number of the lines which correspond and on their characters. When the coincidences are very numerous, as in the case of iron and the solar spectrum, or the lines are characteristically grouped, as in the case of hydrogen and the solar spectrum, we may regard the coincidence as certain; but the progress of science has been greatly retarded by resting important conclusions upon the apparent coincidence of single lines, in spectroscopes of very small resolving power. In such cases, unless other reasons supporting the coincidence are present, the probability of a real coincidence is almost too small to be of any importance, especially in the case of a heavenly body which may have a motion of approach or of recession of unknown amount.

But even here we are met by the confusion introduced by multiple spectra, corresponding to different molecular groupings of the same substance; and, further, to the influence of substances in vapour upon each other; for when several gases are present together, the phenomena of radiation and reversal by absorption are by no means the same as if the gases were free from each other's influence, and especially is this the case when they are illuminated by an electric discharge.

I have said as much as time will permit, and I think indeed sufficient, to show that it is only by the laborious and slow process of most cautious observation that the foundations of the science of celestial physics can be surely laid. We are at present in a time of transition when the earlier and, in the nature of things, less precise observations are giving place to work of an order of accuracy much greather than was formerly considered attainable with objects of such small brightness as the stars.

The accuracy of the earlier determininations of the spectra of the terrestrial elements are in most cases insufficient for modern work on the stars as well as on the sun. They fall much below the scale adopted in Rowland's map of the sun, as well as below the degree of accuracy attained at Potsdam by photography in a part of the spectrum for the brighter stars. Increase of resolving power very frequently breaks up into groups, in the spectra of the sun and stars, the lines which had been regarded as single, and their supposed coincidences with terrestrial lines fall to the ground. For this reason many of the early conclusions, based on observation as good as it was possible to make at the time with the less powerful spectroscopes then in use, may not be found to be maintained under the much greater resolving power of modern instruments.

The spectroscope has failed as yet to interpret for us the remarkable spectrum of the aurora borealis. Undoubtedly, in this phenomenon portions of our atmosphere are lighted up by electric discharges; we should expect, therefore, to recognise the spectra of the gases known to be present in it. As yet we have not been able to obtain similar spectra from these gases artificially, and especially we do not know the origin of the principal line in the green, which often appears alone, and may have therefore an origin independent of that of the other lines. Recently the suggestion has been made that the aurora is a phenomenon produced by the dust of meteors and falling stars, and that near positions of certain auroral lines to lines or flutings of manganese, lead, barium, thallium, iron, etc., are sufficient to justify us in regarding meteoric dust in the atmosphere as the origin of the auroral spectrum. Liveing and Dewar have made a conclusive research on this point, by availing themselves of the dust of excessive minuteness thrown off from the surface of electrodes of various metals and meteorites by a disruptive discharge, and carried forward into the tube of observation by a more or less rapid current of air or other gas. These experiments prove that metallic dust, however fine, suspended in a gas will not act like gaseous matter in becoming luminous with its characteristic spectrum in an electric discharge, similar to that of the aurora. Prof. Schuster has suggested that the principal line may be due to some very light gas which is present in too small a proportion to be detected by chemical analysis or even by the spectroscope in the presence of the other gases near the earth, but which at the height of the auroral discharges is in a sufficiently greater relative proportion to give a spectrum. Lemström, indeed, states that he saw this line in the silent discharge of a Holtz machine on a mountain in Lapland. The lines may not have been obtained in our laboratories from the atmospheric gases, on account of the difficulty of reproducing in tubes with sufficient nearness the conditions under which the auroral discharges take place.

In the spectra of comets the spectroscope has shown the presence of carbon presumably in combination with hydrogen, and also sometimes with nitrogen; and in the case of comets approaching very near the sun, the lines of sodium, and other lines which have been supposed to belong to iron. Though the researches of Prof. H. A. Newton and Prof. Schiaparelli leave no doubt of the close connection of comets with corresponding periodic meteor swarms, and therefore of the probable identity of cometary matter with that of meteorites, with which the spectroscopic evidence agrees, it would be perhaps unwise at present to attempt to define too precisely the exact condition of the matter which forms the nucleus of the comet. In any case the part of the light of the comet which is not reflected solar light can scarcely be attributed to a high temperature produced by the clashing of separate meteoric stones set up within the nucleus by the sun's disturbing force. We must look rather to disruptive electric discharges produced probably by processes of evaporation due to increased solar heat, which would be amply sufficient to set free portions of the occluded gases into the vacuum of space. May it be that these discharges are assisted, and indeed possibly increased, by the recently discovered action of the ultra-violet part of the sun's light? Lenard and Wolf have shown that ultra-violet light can produce a discharge from a negatively electrified piece of metal, while Hallwachs and Righi have shown further that ultra-violet light can even charge positively an unelectrified piece of metal. Similar actions on cometary matter, unscreened as it is by an absorptive atmosphere, at least of any noticeable extent, may well be powerful when a comet approaches the sun, and help to explain an electrified condition of the evaporated matter which would possibly bring it under the sun's repulsive action. We shall have to return to this point in speaking of the solar corona.

A very great advance has been made in our knowledge of the constitution of the sun by the recent work at the Johns Hopkins University by means of photography and concave gratings, in comparing the solar spectrum, under great resolving power, directly with the spectra of the terrestrial elements. Prof. Rowland has shown that the lines of 36 terrestrial elements at least are certainly present in the solar spectrum, while eight others are doubtful. Fifteen elements, including nitrogen as it shows itself under an electric discharge in a vacuum tube, have not been found in the solar spectrum. Some 10 other elements, inclusive of oxygen, have not yet been compared with the sun's spectrum.

Rowland remarks that of the 15 elements named as not found in the sun, many are so classed because they have few strong lines, or none at all, in the limit of the solar spectrum as compared by him with the arc. Boron has only two strong lines. The lines of bismuth are compound and too diffuse. Therefore even in the case of these 15 elements there is little evidence that they are really absent from the sun.

It follows that if the whole earth were heated to the temperature of the sun, its spectrum would resemble very closely the solar spectrum.

Rowland has not found any lines common to several elements, and in the case of some accidental coincidences, more accurate investigation reveals some slight difference of wave-length or a common impurity. Further, the relative strength of the lines in the solar spectrum is generally, with a few exceptions, the same as that in the electric arc, so that Rowland considers that his experiments show "very little evidence" of the breaking up of the terrestrial elements in the sun.

Stas in a recent paper gives the final results of 11 years of research on the chemical elements in a state of purity, and on the possibility of decomposing them by the physical and chemical forces at our disposal. His experiments on calcium, strontium, lithium, magnesium, silver, sodium, and thallium, show that these substances retain their individuality under all conditions, and are unalterable by any forces that we can bring to bear upon them.

(*To be continued.*)

ADDRESS TO THE MATHEMATICAL AND PHYSICAL SECTION OF THE BRITISH ASSOCIATION

BY PROF. OLIVER J. LODGE, D.SC., LL.D., F.R.S., PRESIDENT OF THE SECTION.

During the past year, three or four events call for special mention in an annual deliverance of this kind by a physicist.

One is the Faraday centenary, which was kept in a happy and simple manner by a cosmopolitan gathering in the place so long associated with his work, and by discourses calling attention to the modern development of discoveries made by him.

Another is the decease of the veteran Wilhelm Weber, one of the originators of that absolute system of measurement which, though still ungrasped in its simplicity and completeness by the majority of men engaged in practice, nor even, I fear, wholly understood by some of those engaged in university teaching, has yet done so much, and is destined to do still more, for the unification of physical science, and for a thorough comprehension of its range and its limitations.

A third event of importance during the year is the discovery in America of a binary system of stars, revolving round each other with grotesque haste, and with a proximity to each other such as to render their ordinary optical separation quite impossible. Ideas concerning the future of such systems, if, as seems probable, their revolution period is shorter than their axial period, will readily suggest themselves, in accordance with the principles elaborated by Prof. George Darwin. The subject more properly belongs to our president, but I may parenthetically exclaim at the singular absurdity of the notion which was once propounded by a philosopher, that motion of stars in our line of sight must for ever remain unknown to us; when the mere time of revolution of a satellite, compared with its distance from its central body, is theoretically sufficient to give us information on this head. As a matter of pedagogy it is convenient to observe that the principle called Doppler's, which is generally known to apply to the periodic disturbances called light and sound, applies equally to all periodic occurrences; and that the explanation of anomalies of Jupiter's first satellite by Roemer may be regarded as an instance of Doppler's principle.* Any discrepancy between the observed and the calculated times of revolution of stars round each other can possibly be explained by a relative motion between us and the pair of bodies along the line of sight.

If our text-books clearly recognised this, we should not so often find examination candidates asserting that the apparent time of revolution of a satellite of Jupiter depends on the distance of the earth from that planet, instead of on the speed. I should indeed be sorry to be judged by the performance of my own students, but I fear that many of the less obvious mistakes made by reasonably trained examination candidates are more directly traceable to their teachers than some of us as teachers would like to admit.

The change in the refrangibility of light by reason of the motion of its source, though commonplace enough now, was at first regarded as too small to be observed, and one or two attempts directed to detecting the effect of this principle on the spectra of the stars, or sometimes on sunlight reflected by a 45deg. mirror into the line of the earth's motion (which is not a possible method), wholly failed. I take pleasure in remembering that this effect was clearly observed for the first time by the gentleman we this year honour as our president; and that is by this very means that the latest sensational discovery in astronomy of the rapidly-revolving twin star β-Aurigæ, by Prof. Pickering and the staff connected with the Draper Memorial was made.

The funds for the investigation that led to this result were provided by Mrs. Draper, as a memorial to her late husband; and if β-Aurigæ does not constitute a satisfactory memorial, I am at a loss to conceive the kind of tombstone which the relations of a man of science would prefer.

The fourth event to which it behoves me to refer is the practical discovery of a physical method for colour photography. When I say practical I do not mean commercial, nor do I know that it will ever become applicable to the ordinary business of the photographer. Whether it does or not, it is a sound achievement by physical means of a result which the chemical means hitherto tried failed, some think necessarily failed, to produce. I say practical, because already it had been suggested as possible theoretically; and a step toward it, indeed very near it, had been actually made.

The first suggestion of the method, so far as I know, was made by Lord Rayleigh in the course of a mathematical paper on the reflection of light, and with reference to some results of Becquerel obtained on a totally different plan. He said in a note that if by normal reflection waves of light were converted into stationary waves, they could shake out silver in strata half a wave length apart, and that such strata would give selective reflection and show iridescence.

The colour of certain crystals of chlorate of potash, described in a precise manner by Sir George Stokes,† and also the colours of opal and ancient glass, had been elaborately and completely explained by Lord Rayleigh on this theory of a periodic structure (the laminated structure in the case of chlorate of potash being caused by twinning‡); and he subsequently illustrated it with sound and a series of muslin discs one behind the other on a set of lazy-tongs. Each membrane reflected an inappreciable amount, but successive equidistant membranes reinforced each other's action, and the entire set reflected distinctly one definite note of wave-length twice the distance between adjacent muslins. So also with any series of equidistant strata each very slightly reflecting. They should give selective reflection, and the spectrum of their reflected beam should show a single line or narrow band, corresponding to a wave-length twice the distance of the strata apart.§

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* Dr. Huggins has just pointed out to me a perfectly clear statement to the above effect in Prof. Tait's little book on light.

† *Proc.* Roy. Soc., Feb., 1885.

‡ *Phil. Mag.*, Sept., 1888, pp. 256 and 241.

§ The footnote of Lord Rayleigh on p. 158, *Phil. Mag.*, 1887, vol. xxiv., is brief and forcible enough to quote in full: "A detailed experimental examination of the various cases in which a laminated structure leads to a powerful but highly-selected reflection would be of value. The most frequent examples are met with

Independently of all this, Herr Otto Wiener, imitating Hertz's experiments with ordinary light, in 1889 reflected a beam directly back on itself, and, by interposing a very thin collodion film at extraordinarily oblique incidence, succeeded in the difficult experiment of so magnifying by the cosine of inclination the half wave-length, as to get the silver deposited in strata of visible width, and thus to photograph the interference nodes themselves at the places where they were cut by the plane of the film.*

Then M. Lippmann, using a thicker film, not put obliquely but normal to the light, obtained the strata within the thickness of the film itself—hundreds of layers; and so, employing incidence light of definite wave-length, was able to produce a stratified deposit, which reflected back at appropriate incidences the same wave-length as produced it; thus reproducing, of course, the definite colour.

It is probable that the silver is first shaken out at the ventral segments, but that the strata so formed are thick and blurry. I conjecture that by over-exposure this deposit is nearly all mopped up again, traces being left only at the nodes, where the action is very feeble and takes a long time to occur; but that these residual strata, being fairly sharp and definite, will be likely to give much better effects. And so I suppose that these are what are actually effective in obtaining M. Lippmann's very interesting, though not yet practically useful, result.

I now leave the retrospect of what has been done, although many other topics might usefully detain us, and I proceed to glance forward at the progress ahead, and at the means we have for effectively grappling with our due share of it.

There is a subject which has long been in my mind, and which I determined to bring forward whenever I had a cathedral opportunity of doing so; and now, if ever, is a suitable occasion. It is to call attention to the fact that the further progress of physical science in the somewhat haphazard and amateur fashion in which it has been hitherto pursued in this country is becoming increasingly difficult, and that the quantitative portion especially should be undertaken in a permanent and publicly supported physical laboratory on a large scale. If such an establishment were to weaken the sinews of private enterprise and individual research it should be strenuously opposed; but in my opinion it would have the opposite effect, by relieving the private worker of much which he can only with great difficulty, sacrifice, and expense undertake. To illustrate more precisely what I mean, it is sufficient to recall the case of astronomy. The amateur astronomer has much work lying ready to his hand, and he grapples with it manfully. To him is left the striking out of new lines and the guerilla warfare of science. Skirmishing and brilliant cavalry evolutions are his natural field; he should not be called upon to take part in the general infantry advance. It is wasting his energies, and he could not do it in the long run well. What, for instance, would have been the state of astronometry—the nautical almanac department of astronomy—without the consecutive and systematic work of the National Observatory at Greenwich? It may be that some enthusiastic amateurs would have devoted their lives to this routine kind of work, and here at one time and there at another a series of accurate observations would have been kept for several years. Pursued in that way, however, not only would the effort be spasmodic and temporary, but the energy and enthusiasm of those amateurs would have been diverted from the pioneering more suited to them, and have been cramped in the groove of routine, eminently adapted to a permanent official staff, but not wholesome for an individual.

Long-continued consecutive observations may be made by a leader of science, as functions may be tabulated by an eminent mathematician; but if the work can be done almost equally well (some would say better) by a professional observer or computator, how great an economy results.

Now all this applies equally to physics. The ohm has been determined with four-figure, perhaps with five-figure, accuracy; but think of the list of eminent men to whose severe personal labour we owe this result, and ask if the spoil is worth the cost. Perhaps in this case it is, as a specimen of a well-conducted determination. We must have a few specimens, and our leaders must show us the way to do things. But let us not continue to use them for such purposes much longer. The quest of the fifth or sixth decimal is a very legitimate, and may become a very absorbing quest, but there are plenty of the rank and file who can undertake it if properly generalled and led; not as isolated individuals, but as workers in a national laboratory under a competent head and a governing committee. By this means, work far greater in quantity, and in the long run more exact in quality, can be turned out, by patient and conscientious labour, without much genius, by the gradual improvement of instrumental means, by the skill acquired by practice, and by the steady drudgery of routine. Paris has long had one form of such an institution in the Conservatoire des Arts et Métiers, and has been able to impose the metric system on the civilised world in consequence. It can also point to the classical determinations of Regnault as the fruits of just such a system. Berlin is now starting a similar or a more ambitious scheme for a permanent national physical institute. Is it not time that England, who in physical science, I venture to think, may in some sort claim a leading place, should be thinking of starting the same movement?

The Meteorological and Magnetic Observatory at Kew (in the inauguration of which this association took so large a part) is a step, and much useful quantitative work is done there. The new Electric Standardising Laboratory of the Board of Trade is another, and in some respects, perhaps, a still closer approximation to the kind of thing I advocate. But what I want to see is a much larger establishment, erected on the most suitable site, limited by no speciality of aim nor by the demands of the commercial world, furnished with all appropriate appliances, to be amended and added to as time goes on and experience grows, and invested with all the dignity and permanence of a national institution; a physical observatory, in fact, precisely comparable to the Greenwich Observatory, and aiming at the very highest quantitative work in all departments of physical science. That the arts would be benefited may be assumed without proof. It is largely the necessity of engineers that has inspired the amount of accuracy in electrical matters already attained. The work and appliances of the mechanical engineer eclipse the present achievements of the physicist in point of accuracy, and it is by the aid of the mechanician and optician that precision even in astronomy has reached so high a stage. There is no reason why physical determinations should be conducted in an amateur fashion, with comparatively imperfect instruments, as at present they mostly are. Discoveries lie along the path of extreme accuracy, and they will turn up in the most unexpected way. The aberration of light would not have been discovered had not Bradley been able to measure to less than 1 part in 10,000, and what a brilliant and momentous discovery it was! He was aiming at the detection of stellar parallax, but the finite velocity of light was a bigger discovery than any parallax. This is the type of result which sometimes lurks in the fifth decimal, and which confers upon it an importance beside which the demands of men who wish to serve the taste and the pocket of the British public sink into insignificance.

In a national observatory accuracy should be the one great end; the utmost accuracy in every determination that is decided on and made. Only one thing should be more thought of than the fifth significant figure, and that is the sixth. The consequences flowing from the results may safely be left; such as are not obvious at once will distil themselves out in time. And the great army of outside physicists, assured of the good work being done at headquarters, will (to speak again in astronomical parable) cease from peddling with taking transits or altitudes, and will be free to discover comets, to invent the spectroscope, to watch solar phenomena, to chemically analyse the stars, to devise celestial photography, and to elaborate still more celestial theories; all of which novelties in their maturity may be handed over to the National Observatory, to be henceforth incorporated with, and made part of, its routine life; leaving the advance guard and skirmishers free to explore fresh territory, secure in the knowledge that what they have acquired will be properly surveyed, mapped, and utilised without further attention from them. As to the practical applications, they may in any case be left to take care of themselves. The instinct of humanity in this direction, and the so-called solid gains associated with practical achievements, will always secure a sufficient number of acute and energetic workers to turn the new territory into arable land and pasture adapted to the demands of the average man. The labour of the agriculturist in rendering soil fertile is, of course, beyond praise; but it is not the work of the pioneer. As Mr. Huxley eloquently put it, when contrasting the application of science with the advance of science itself, speaking of the things of commercial value which the physical philosopher sometimes discovers: "Great is the rejoicing of those who are benefited thereby, and, for the moment, science is the Diana of all the craftsmen. But even while the cries of jubilation resound, and this flotsam and jetsam of the tide of investigation is being turned into the wages of workmen and the wealth of capitalists, the crest of the wave of scientific investigation is far away on its course over the illimitable ocean of the unknown.'

I have spoken of the work of the national laboratory as devoted to accuracy. It is hardly necessary to say that it will be also the natural custodian of our standards, in a state fit for use and for comparison with copies sent to be certified. Else perhaps some day our standard ohm may be buried in a brick wall at Westminster, and no one living may be able to recall precisely where it is.

But, in addition to these main functions, there is another, equally important with them, to which I must briefly refer. There are many experiments which cannot possibly be conducted by an individual, because 40 or 50 years is not long enough for them. Secular experiments on the properties of materials—the elasticity of metals, for instance; the effect of time on molecular arrangement; the influence of long exposure to light, or to heat, or to mechanical vibration, or to other physical agents.

Does the permeability of soft iron decay with age, by reason of the gradual cessation of its Ampèrian currents? Do gases cool themselves when adiabatically preserved, by reason of imperfect elasticity or too many degrees of freedom of their molecules? Unlikely, but not impossible. Do thermo-electric properties alter with time? And a multitude of other experiments which appear specially applicable to substances in the solid state—a state which

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in the organic world. It has occurred to me that Becquerel's reproduction of the spectrum in natural colours upon silver plates may perhaps be explicable in this manner. The various parts of the film of subchloride of silver with which the metal is coated may be conceived to be subjected during exposure to *stationary* luminous waves of nearly definite wave-length, the effect of which might be to impress upon the substance a periodic structure occurring at intervals equal to *half* the wave-length of light; just as a sensitive flame exposed to stationary sonorous waves is influenced at the loops, but not at the nodes (*Phil. Mag.*, March, 1879, p. 153). In this way the operation of any kind of light would be to produce just such a modification of the film as would cause it to reflect copiously that particular kind of light. I abstain at present from developing this suggestion, in the hope of soon finding an opportunity of making myself experimentally acquainted with the subject."

* Wiedemann's *Annalen*, vol. xl., 1890.

is more complicated, and has been less investigated, than either the liquid or the gaseous; a state in which time and past history play an important part.

Whichever of these long researches requires to be entered on, a national laboratory, with permanent traditions and a continuous life, is undoubtedly the only appropriate place. At such a place as Glasgow the exceptional magnitude of a present occupant may indeed inspire sufficient piety in a successor to secure the continuance of what has been there begun: but in most college laboratories, under conditions of migration, interregnum, and a new *régime*, continuity of investigation is hopeless.

I have, at any rate, said enough to indicate the kind of work for which the establishment of a well-furnished laboratory with fully-equipped staff is desirable, and I do not think that we as a nation shall be taking our proper share of the highest scientific work of the world until such an institution is started on its career.

There is only one evil which, so far as I can see, is to be feared from it. If ever it were allowed to impose on outside workers as a central authority from which infallible dicta were issued, it would be an evil so great that no amount of good work carried on by it could be pleaded as sufficient mitigation.

If ever by evil chance such an attitude were attempted, it must rest with the workers of the future to see that they permit no such shackles, for if they are not competent to be independent, and to contemn the voice of authority speaking as mere authority, if their only safeguard lies in the absence of necessity for struggle and effort, they cannot long hope to escape from the futility which surely awaits them in other directions.

I am thus led to take a wider range, and, leaving temporary and special considerations, to speak of a topic which is as yet beyond the pale of scientific orthodoxy, and which I might, more wisely, leave lying by the roadside. I will, however, take the risk of introducing a rather ill-favoured and disreputable-looking stranger to your consideration, in the belief—I might say, in the assured conviction—that he is not all scamp, and that his present condition is as much due to our long-continued neglect as to any inherent incapacity for improvement in the subject.

I wish, however, strenuously to guard against its being supposed that this association, in its corporate capacity, lends its countenance to, or looks with any favour on, the outcast. What I have to say—and after all it will not be much—must rest on my own responsibility. I should be very sorry for any adventitious weight to attach to my observations on forbidden topics from the accident of their being delivered from this chair. At the same time I am distinctly one of the army of scientific workers; one of the many who have devoted their lives to the service of truth in general, so far as they are able to perceive it; and not only have I the right to express myself concerning matters on which I have worked, but I conceive it to be a duty, from which, if I shrank, I should shrink from no higher motive than simple cowardice. I therefore make no apology whatever for saying what I have to say, but I do hope that any quacks or professional exhibitors who would be able to make capital out of an utterance by a mouthpiece of a section of the British Association will be prevented from any attempt of the kind by this prelude and the assertion of merely personal responsibility. The objection at which I have now hinted is the only one that seems to me to have any just weight, and on all other counts I am willing to incur such amount of opprobrium as naturally attaches to those who enter on a region where the fires of controversy are not extinct, and in which it is quite impossible, as well as undesirable, for everyone to think alike.

It is but a platitude to say that our clear and conscious aim should always be truth, and that no lower or meaner standard should ever be allowed to obtrude itself before us. Our ancestors fought hard and suffered much for the privilege of free and open enquiry, for the right of conducting investigation untrammelled by prejudice and foregone conclusions, and they were ready to examine into any phenomenon which presented itself. This attitude of mind is perhaps necessarily less prominent now, when so much knowledge has been gained, and when the labours of many individuals may be rightly directed entirely to its systematisation and a study of its inner ramifications; but it would be a great pity if a too absorbed attention to what has already been acquired, and to the fringe of territory lying immediately adjacent thereto, were to end in our losing the power of raising our eyes and receiving evidence of a totally fresh kind, of perceiving the existence of regions into which the same processes of enquiry as had proved so fruitful might be extended, with results at present incalculable and perhaps wholly unexpected. I myself think that the ordinary processes of observation and experiment are establishing the existence of such a region—that, in fact, they have already established the truth of some phenomena not at present contemplated by science, and to which the orthodox man shuts his ears.

For instance, there is the question whether it has or has not been established by direct experiment that a method of communication exists between mind and mind irrespective of the ordinary channels of consciousness and the known organs of sense, and, if so, what is the process. It can hardly be through some unknown sense organ, but it may be by some direct physical influence on the ether, or it may be in some still more subtle manner. Of the process I as yet know nothing. For brevity it may be styled "thought-transference," though the name may turn out to be an unsuitable one after further investigation. Further investigation is just what is wanted. No one can expect others to accept his word for an entirely new fact, except as establishing a *prima facie* case for investigation.

But I am only now taking this as an instance of what I mean. Whether it be a truth or a fiction, there is not, I suppose, one of the recognised scientific societies who would receive a paper on the subject. There are individual scientific men who have investigated these matters for themselves. There are others who are willing to receive evidence, who hold their minds open and their judgment in suspense; but these are only individuals. The great majority, I think I am right in saying, feel active hostility to these researches and a determined opposition to the reception or discussion of evidence. And they feel this confirmed scepticism, as they call it, not after prolonged investigation—for then it might be justified—but sometimes after no investigation at all. A few tricks at a public performance, or the artifices of some impostor, and they decline to consider the matter further.

That individuals should take this line is, however, natural enough; they may be otherwise occupied and interested. Everybody is by no means bound to investigate everything, though, indeed, it is customary in most fields of knowledge for those who have kept aloof from a particular enquiry to defer in moderation to those who have conducted it, without feeling themselves called upon to express an opinion. Some there are, no doubt, who consider that they have given sufficient time and attention to the subject with only negative results. Their evidence is, of course, important; but, plainly, negative evidence should be of immense bulk and weight before it can outweigh even a moderate amount of positive evidence. However, it is not of the action of individuals that I wish to speak: it is of the attitude to be adopted by scientific bodies in their corporate capacity; and for a corporate body of men of science, inheritors of the hard-won tradition of free and fearless enquiry into the facts of nature untrammelled by prejudice, for any such body to decline to receive evidence laboriously attained and discreetly and inoffensively presented by observers of accepted competency in other branches, would be, if ever actually done and persisted in, a terrible throwing away of their prerogative, and an imitation of the errors of a school of thought against which the struggle was at one time severe.

(*To be continued.*)

ADDRESS TO THE MECHANICAL SCIENCE SECTION OF THE BRITISH ASSOCIATION.

BY T. FORSTER BROWN, M.INST.C.E., PRESIDENT OF THE SECTION.

I feel extremely diffident in assuming the presidential chair of Section G at the present meeting of the British Association.

The addresses of my eminent predecessors have, year by year, in the best language, and in the most condensed form, gauged the progress of and indicated the direction in which further improvements in mechanical science may be looked for. In so large a field as that of mechanical engineering my somewhat limited knowledge will not admit of my following very closely in their footsteps; but possibly, by tracing the modern practice of this branch as applied to mining operations in Great Britain, I may be able to submit some points of interest to mechanical engineers.

Great progress has been made in mechanical science since the British Association met in the Principality of Wales 11 years ago; and some of the results of that progress are exemplified in our locomotives, marine engineering, and in such works as the Severn Tunnel, the Forth and Tay Bridges, and the Manchester Ship Canal, which is now in progress of construction.

In mining, the progress has been slow, and it is a remarkable fact that, with the exception of pumping, the machinery in use in connection with mining operations in Great Britain has not, in regard to economy, advanced so rapidly as has been the case in our manufactures and marine.

This is probably due, in metalliferous mining, to the uncertain nature of the mineral deposits not affording any adequate security to adventurers that the increased cost of adopting improved appliances will be reimbursed; whilst in coal mining, the cheapness of fuel, the large proportion which manual labour bears to the total cost of producing coal, and the necessity for producing large outputs with the simplest appliances, explain, in some measure, the reluctance with which high-pressure steam compound engines, and other modes embracing the most modern and approved types of economising power, have been adopted.

Metalliferous mining, with the exception of the working of iron ore, is not in a prosperous condition owing to causes to which it is unnecessary to refer; but in special localities, where the deposits of mineral are rich and profitable, progress has been made within a recent period by the adoption of more economical and efficient machinery.

For example, at the Tincroft Tin Mine, in Cornwall, a compound winding plant has been erected by Messrs. Harvey, of Hayle, of which the following are particulars: The high-pressure cylinder is 17in. in diameter and steam-jacketed, and the low-pressure cylinder is 30in. in diameter, each having a stroke of 6ft. A condenser is worked by levers off the cross-head of the low-pressure cylinder. The drum is 8ft. 6in. in diameter, and of the plain cylindrical type. The engine is fitted with steam reversing gear, and an auxiliary steam valve for admitting high-pressure steam to either end of low-pressure cylinder when required. The working pressure of steam is 90lb. per square inch. This engine has proved so satisfactory that the management of the mine has been induced to erect a new horizontal condensing compound air-compressing engine in place of their existing plant. This engine will have high and low pressure cylinders of 15½in. and 27in. diameter respectively, by 48in. stroke, and the air cylinder is 22in. in diameter, with an equal stroke, and is fitted with Trestrail's patent inlet and outlet valves, and is arranged for a working pressure of 100lb. per square inch.

At the Greenside Lead Mines, near Ullswater, a waterfall of upwards of 100 h.p. is now being utilised by means of a turbine to drive dynamos, the energy from which is transmitted for the purposes of winding, pumping, and lighting; and, again, at the Morgan Gold Mines, near Dolgelly, there is a modern example of the successful utilisation of water power for compressed air, and for driving 40 head of stamps. The water power for driving the mill is obtained from the River Mawddach, and is brought on to a 22in. turbine, with a 68ft. head; this fall, with 650 cubic feet of water, easily drives the mill, stone breakers, etc., and with 800 cubic feet of water applied, if required, the water power can be raised to 100 h.p.

And, as an example of the very large amount of mechanical power applied in exceptional circumstances to metalliferous mining operations, the Whicham Hæmatite Iron Mines, in South Cumberland may be named, where the quantity of water raised from a depth of 552ft. occasionally exceeds 4,800 gallons per minute, the machinery employed consisting of—

Firstly, a Cornish beam condensing pumping engine, having a 90in. diameter cylinder by 11ft. stroke, with a 10ft. stroke in the pumps. The beam weighs 50 tons. There are attached to this engine three pump rams, each 28in. in diameter, fixed at certain points in the shaft, the bottom ram being fixed 552ft. below the surface, from which level the whole of the water is pumped. The quantity of water delivered per minute is 2,210 gallons. There is also another Cornish beam condensing pumping engine, with a cylinder of 110in. in diameter by 11ft. stroke, with a 9ft. stroke in the pumps. This beams weighs 55½ tons. Attached to this engine are three 30in. diameter pump rams, forcing from the same level as that beforementioned a quantity of 2,295 gallons of water per minute. In November and December during heavy floods as much as 4,680 gallons have been pumped from this mine per minute by these two engines.

The average consumption of coal by these engines is equal to about 4lb. per indicated horse-power.

There is another engine erected at this mine which is kept in reserve in the event of anything happening to either of the two other engines which I have described—viz., a tandem horizontal compound condensing pumping engine, having a 40in. high-pressure and a 70in. low-pressure cylinder by 9ft. stroke. This engine is fitted with Davey's differential valve gearing. There is attached to this engine two 24in. diameter pump rams fixed at a point 372ft. below the surface. These pumps are capable of dealing with 280 gallons of water with each stroke of the engine, and the maximum speed is seven strokes per minute, which represents, therefore, 1,960 gallons of water per minute. Provision is made with this engine to extend the pumps to a lower level when necessary.

The weight of the pumps and pipes connected with these engines is about 250 tons.

In the raising of coal from our mines and placing it on board ship in our docks there is a vast amount of machinery employed, much of which is now of an obsolete type. Where, however, new winnings have been made, or where in old mines it has been found necessary to replace the old machinery by new, the question of efficiency and at the same time economy in machinery has of late years received serious attention.

The consideration of the question of economy in the employment of steam in coal-mining operations has resulted in boilers of the most modern construction being erected, working to pressures varying from 80lb. to 150lb. per square inch, as compared with pressures varying from 40lb. to 50lb. per square inch in the old boilers, whilst the various engines are now being constructed on the most modern and improved principle.

Compressed air has for many years been used extensively in our coal mines as a motive power. Electricity also has made rapid strides in the same direction; and I have no doubt that, in conjunction with a better type of machinery for the compression and use of air, will eventually become the principal agent in underground mechanical operations.

Many large electrical installations have already been in use for a considerable period. Notably amongst the number I may mention that at Messrs. Locke and Co.'s St. John's Colliery, Normanton, where both hauling on the endless-rope system and pumping are very largely adopted, and it has been proved that a useful effect equal to 65 per cent. can be obtained. This high rate of efficiency is undoubtedly very satisfactory. I am, however, of opinion that there is still great room for improvement in electrical plant before it will be adopted in preference to other machinery now in general use, especially in gaseous mines, and these improvements must embrace a certain means of rendering sparking absolutely harmless under all conditions, for it involves not only the question of the increased efficiency of one class of machinery over another, but also the protection of human life.

There must also be devised a ready means of reversing the power, so that the system of haulage known as the main and tail-rope system can be applied with equal safety and readiness in any part, as compared with absolute safety in the use of compressed air.

An electrical hauling plant, to be worked on this system (which, I am sure, will be watched with very great interest), is now erected at one of the Plymouth collieries in this district by an eminent firm of electricians as a trial and demonstration of what can be done in this direction. This will comprise, when fully complete, a generating plant at the top of the pit, and two electrically-driven hauling engines underground, connected by a suitable cable carried down the shaft and along the roadway for some 1,200 yards.

The generating plant and one hauling engine are now erected, and the other hauling engine will shortly be ready.

The generating plant consists of a 40-h.p. compound engine working at 110 revolutions per minute; this engine drives by belt a specially constructed dynamo, which is of a horizontal pattern, built on a wrought-iron girder bed-plate. It is compound wound, and capable of giving off 160 amperes with 500 volts pressure, running at 500 revolutions per minute.

The cable, which is 3,200 yards in length, is made of 37 strands of No. 14 high conductivity copper wire, highly insulated with vulcanised bitumen, double taped, and surrounded with two layers of jute yarn compounded between each, and is protected by a double sheath of No. 8 steel wire. It is of sufficient size to carry the necessary current, and in case of falls of roof it has been constructed so that it will stand a shearing strain of 10 tons per square inch.

The hauling engine consists of two drums, each fitted with a clutch and foot brake. The drum shaft is driven from a countershaft by spur gearing, and this countershaft is driven from the motor by six ropes 1in. in diameter.

The motor is a shunt-wound machine, built to run at 600 revolutions per minute, and works with 80 amperes at 450 volts, and is able to take 160 amperes without harm at starting. The whole engine is mounted on a wrought-iron bed-frame. The motor will be reversed by a specially-designed switch, the efficiency of which has yet to be proved. The useful effect of this plant, when working at full power, is expected to be from 60 to 65 per cent.

Possibly the leather belting and ropes used for transmitting the power from the motor to the hauling-drums or pipes might with advantage be replaced with something less liable to be damaged by the rough usage and other contingencies usually met with underground.

As I have previously mentioned, compressed air is another motive power very largely used in coal-mining, it being not only absolutely safe in gaseous atmospheres, but tends to reduce any danger which might exist from sudden outbursts of gas by assisting the ventilation. This may be considered as rather an expensive means of assisting ventilation; but it is very seldom that the air is used direct from the mains for this purpose. A very interesting paper was read at the Newcastle-upon-Tyne meeting of this association, in 1889, by Prof. Alex. B. W. Kennedy, on the experiments he had made in Paris upon the transmission of power by compressed air, in which he states that an indicated efficiency of 31 per cent. can be got from cold air, and 45 per cent. from air which has been heated after compression. It is very doubtful, however, if in any compressed-air installation used in coal-mining there is more than 30 per cent. of useful effect obtained; in many instances it is much less, as it is impossible in almost every case to heat the air after it has passed into the mine; and another source of loss is due to leakage, caused in a great measure by the occasional upheaval of the ground disturbing the pipes. It is thus obvious that compressed air is more costly than electricity; but up to the present time it is the only absolutely safe power which is capable of being conveyed long distances underground in gaseous mines.

A very large compressing plant has quite recently been erected in this district, and another will very shortly be installed; this latter will consist of two pairs of tandem compound steam engines, each pair having two high-pressure cylinders 22in. in diameter, and two low-pressure cylinders each 40in. in diameter, by 5ft. stroke. The air cylinders are 34in. in diameter, one being placed behind each low-pressure cylinder. Each high-pressure cylinder is provided with variable expansion valves, which can be adjusted whilst the engines are working. The independent condensing apparatus consists of a pair of engines having 10in. diameter cylinders, and 20in. diameter air pumps, by 2ft. 6in. stroke, and are so arranged that they can be worked together as a pair or as single engines and condensers.

The pressure of steam at the boilers will be 150lb. per square inch, so that a high degree of expansion may be obtained, and as the inlet and outlet valves of the air cylinders are of large area, and are perfectly free to act in sympathy with the pistons in the air cylinders, it is only reasonable to expect the highest degree of efficiency which can be obtained from steam power applied to compressing air. Each pair of air-compressing engines will be capable of developing at least 800 h.p., or a total of 1,600 i.h.p. in the installation.

No provision has been made in this plant for compounding the air cylinders or the motors; but it has been pointed out by Prof. Elliott, of the Cardiff University, in a very interesting and able paper read before the South Wales Institute of Engineers, that great economy will result in compounding the air and motors. Prof. Elliott estimates the extra efficiency, under certain conditions of high pressure, as upwards of 11 per cent. Further investigation in regard to defining the relative economy of using high and low pressed air for underground mining operations, and the relative cost of the plant adapted for the production and application of each, is required before it can be definitely decided that air of a pressure above four atmospheres, but with air cylinders and motors compounded, will result in real economy. It appears on the first blush as if we might look in the direction indicated to secure a material increase in the effective power obtainable from compressed air.

In some of our coalfields very hard seams or veins of coal are met with, and various kinds of machinery have been devised to assist the coal hewer in severing the coal from the solid strata, and electrical appliances have in this class of machinery been more or less successful. It appears to me, however, that there is a want of simplicity about the majority of the machines which have come under my notice, which will operate against their general adoption.

In the conveyance of coal underground, from the face of the workings where it is loaded into trams by the workmen to the bottom of the shaft, several systems of haulage are adopted, either worked direct by steam power, compressed air, or electrical motors, the principal of which are known as the endless-rope, main-and-tail-rope, and main-rope systems. The two former systems are used where the ground is either level or undulating, and where power has to be applied to haul the trams or tubs in both directions, and the latter system is generally used where there is a gradient in one direction, sufficient to allow the trams or tubs to run by gravitation, and haul the rope after them. The cost of the conveyance of coal underground is a very considerable item in South Wales, probably amounting to £600,000 or £700,000 per annum, and consequently has caused great attention to be given to the subject. It has been found that the endless-rope system, where it can be conveniently applied, is the cheapest. This system, however, necessitates the laying and maintaining of either a double line of rails, or frequent passing points or loops; and as the nature of the strata does not always admit of the roads being made and maintained wide enough for this to be done, the main-and-tail system, which requires a single line only, has in that event to be adopted. The distance to which some of these haulage systems extend is very great (in some cases exceeding three miles); and, having regard to the large quantities which have to be conveyed by mechanical haulage in single collieries—in many instances 1,000 to 1,500 tons of coal in 10 hours—very good and powerful machinery is required, and it is not unusual to have engines of 600 i.h.p. placed underground for this purpose. In other cases where the coal is brought from several districts to the bottom of the shafts, smaller engines are used. For endless-rope haulage, the speed at which the trams or tubs travel is from two to six miles per hour, as against from 10 to 20 miles per hour by the main-and-tail system; thus there is much greater wear and tear in the latter than in the former. The type of engine usually adopted for this work varies considerably according to circumstances, and the ideas of the engineer by whom the work is planned. They are, however, invariably horizontal, and fitted with a second motion shaft, on which the hauling drums are arranged. There is still a large number of horses employed underground, at very great cost, principally to collect the trams from the colliers and convey them to the station, from which point the engine hauls them, and it is to this class of haulage that I would particularly direct the attention of mechanical engineers. What is required is an absolutely safe and simple means of light haulage, made as portable as possible, so that it can be readily moved from one position to another, as circumstances may require, and arranged so as to replace the horses.

Thus, the coal is brought to the bottom of the shaft, and thence up the shaft by means of the winding engine. This class of engine has of late years been very materially improved. Instead of the low-pressure vertical beam condensing engine, which was so commonly in use many years ago, and types of which are still in existence, we have now the high-pressure compound condensing engine, working with a boiler pressure varying from 80lb. to 150lb. per square inch. Some of our winding engines are very powerful, and run at very high velocities. This will be the more readily understood from the fact that at some pits the carriages on which the coal is raised in the shaft attain a speed equal to from 40 to 45 miles per hour, and the dead load lifted is as great as 20 tons each lift. A few of the leading sizes of a large pair of winding engines now in use at one of the collieries in this district may be mentioned. The engines are vertical, with inverted cylinders of 54in. in diameter, and admit of a 7ft. stroke. The cylinders are steam-jacketed, and the valves double beat, placed in pairs in nozzle-boxes fixed to the port branches at the top and bottom of each cylinder. The valves are worked by the ordinary rocking lifters, to which is added, for the steam valves, the simple triple-expansion gear first introduced by Mr. Barclay, of Kilmarnock. The cylinders are supported by double A frames of cast iron fixed to heavy cast-iron bed-plates, to which also is attached the main shaft plummer blocks. The winding-drum is of the conical type, graduating from 16ft. to 32ft., and is made of steel plates and ribs and cast-iron centres. The total weight of the drum, drum shaft, and the engine cranks, and one rope, exceeds 100 tons. The engine is fitted with a powerful steam brake, and also a self-acting reversing gear, which reversing gear also applies the steam brake, in case of any neglect on the part of the engine man. There is also being built for a colliery in this coalfield a large pair of compound condensing winding engines by Messrs. Fowler, of Leeds, which will embrace all the latest improvements. They will consist of a pair of horizontal compound winding engines fitted with condensers; the high-pressure cylinder, being 32in. in diameter by 5ft. stroke, will actuate one crank, whilst the low-pressure cylinder, 48in. in diameter by 5ft. stroke, will actuate the other crank. Both cylinders are fitted with Cornish valves, and on the high-pressure cylinder there is fitted automatic variable expansion, worked by a governor, and the initial pressure of steam will be 150lb. per square inch. This engine will be fitted with a plain cylindrical drum, 18ft. in diameter, and a balance-rope will be attached to the underside of the carriages, so that everything will be in perfect balance.

Between the high and low pressure cylinders is a receiver, on which is fixed a valve arrangement by which the steam can be expanded out of the receiver, or live steam can be admitted into it. This arrangement greatly facilitates the ease of starting the engines.

As it is intended to raise the load from the bottom to the top of the shaft in 40 seconds, and as during part of each lift the speed will probably get up to 3,500ft. per minute, the engines at that time will probably indicate 1,500 h.p.

Mechanical ventilation, by exhausting the air, has almost entirely superseded the furnace ventilation in general use many years ago, and which created a current by heat. There are many types of fans; the best known are the "Schiele," "Guibal," and "Waddell." Some very large fans are now in use, and at the present time the large quantity of 500,000 cubic feet of air per minute is capable of being passed through one of the mines in this district by a "Schiele" fan, with a water-gauge of 4in. A very exhaustive series of trials is being made by a committee appointed by the North of England Institute of Engineers, which I have no doubt will bring to light many interesting features in the various types of fans in general use, and indicate accurately the relative economic values of each.

Some of our coal mines are very heavily watered, and this involves large and costly pumping machinery, which takes various forms, the most generally used of which is perhaps the old-fashioned but economical Cornish vertical condensing steam engine, which, with its heavy rods and pumps, occupies a considerable portion of the room in the shaft. In recent years, however, there has been a tendency to apply the direct-acting forcing engine, fixed at the bottom of the shaft, of which there are various forms, and still more recently pumps worked by electrical power are being brought into use, and in underground workings far away from the shafts this power seems eminently suitable, as the work in pumping required can be so regulated as to be constant, thereby reducing the risk of danger from sparking.

Many excellent forms of direct-acting pumping engines have been designed, the most economical being the compound condensing direct acting ram-pump, which takes up little space. Perhaps the worst feature in adopting direct-acting pumps is the fact that steam must be conveyed down the shaft, which means a certain loss by condensation, a loss which can, however, be very materially reduced by having the steam-pipes properly protected from exposure by suitable coverings. The steam and water pipes for this type of pump take up much less pit room than those of the Cornish pump, and this is of very great moment where the area of the shafts is limited.

A type of pump which has been adopted in some of our northern mines, and which I should like to notice, is the hydraulic pump patented by Mr. Joseph Moore, C.E., of Glasgow.

The object of this invention is attained by means of hydraulic pressure, and one of the prominent advantages gained is that it enables the steam engine which generates the power to be placed on the surface and near to the boilers, thus obviating the loss due to the condensation of steam when conveyed great distances. To the steam engine on the surface is attached a double-acting power ram of the ordinary type, and there are also similar power rams attached to the pump underground. These rams are connected to each other by small pipes filled with water, which when under pressure convey the reciprocating motion of the engine on the surface to the pump underground.

Another type of pumping engine now largely used in mining is that manufactured by Messrs. Hathorn, Davey, and Co., of Leeds. A notable instance of this type of engine is at Bradley, in Staffordshire, where one engine raises 4,000,000 gallons a day a height of 490ft. The chief improvements introduced in these engines of late years have been the trip gear, by means of which the steam communication between the high and low pressure cylinders is automatically stopped in case of accident, and the consequent cushioning of the steam in the high-pressure cylinder brings the engine gradually to rest without shock; and also the pausing gear, by means of which a definite interval between the strokes is obtained. In heavy lifts, this is of great advantage, by giving time for the valves to settle down to their seats at the end of each stroke, which minimises wear and tear, and it also enables the engine, when running at one or two strokes a minute, to make a brisk stroke and then pause, thus obviating the disadvantage of water slipping back through the valves, which is always the case when an engine makes a very slow stroke.

Another type of engine, which is increasing in favour, is the hydraulic engine at the bottom of the shaft, actuated by a steam engine at the top, on a similar principle to that introduced many years ago by Lord Armstrong for working the machinery in docks. This system possesses the advantage of occupying the minimum of space either at the pit top or in the shaft, and the power can be applied at any point in the pit without the inconvenience which attends the actuation of pumps by spear rods at any other point than at the bottom of the shaft. A plant of this kind has been working at Marseilles for some years, raising 1,700 gallons per minute 311ft. high, with an accumulator pressure of 42 atmospheres.

On leaving the carriage the trams of coal are weighed, and the coal is then tipped on to the screen, where it is cleaned and divided into the necessary number of saleable sizes (which is usually regulated by the quality of the coal), and then placed in the trucks for transportation. Considerable improvements have recently been made in our screening apparatus, which is probably due, partly to the increased proportion of dirt or dross found in some of the seams now worked, and partly to the necessity of having a more improved and effective apparatus, having regard to the increased cost of working the coal, and consequently to its increased value. The improvements in this direction have taken the form chiefly of travelling belts, moving at a slow speed, in lieu of the ordinary falling screen.

At the docks also, the machinery for placing the coal on board ship has been greatly improved, so as to prevent breakage, one of the most recent improvements being the movable tip, which can be adjusted to suit the varying sizes of ships. Some of these tips are made on the principle of the jib crane, the coal being tipped from the truck into large iron boxes, which are lowered into the ship's hold, and the coal dropped out of the bottom of the box. Others are fitted with what might be termed an auxiliary crane, by which the coal is lowered in boxes into the ship's hold, the truck being first of all placed on a cradle, which is raised by hydraulic rams to the necessary height, when it is tipped to such an angle as to cause the coal to run out of the truck through a shoot, extending over the ship's hatchway, into what is termed the anti-breakage box. The box being filled is then lowered into the ship's hold, but its use is discontinued as soon as sufficient quantity of coal has been loaded to form a cone sufficiently large to prevent further breakage. The anti-breakage box is then swung out of the way, and the coal allowed to slide from the shoot on to the cone and into the hold, where it is trimmed into position.

Summarising the position of mechanical science as applied to our coal-mining industry in this country, it may be observed that there is a general awakening to the necessity of adopting, in the newer and deeper mines, more economical appliances.

It is true that it would be impracticable, and probably unwise, to alter much of the existing machinery, but, by the adoption of the best-known types of electrical plant, and air compression in our new and deep mines, the consumption of coal per horse-power would be reduced, and the extra expense, due to natural causes, of producing minerals from greater depths would be substantially lessened. The consumption of coal at the collieries in Great Britain alone probably exceeds 10,000,000 tons per annum, and the consumption per horse-power is probably not less than 6lb. of coal, and it is not unreasonable to assume that, by the adoption of more efficient machinery than is at present in general use, at least one-half of the coal consumed could be saved. There is, therefore, in the mines of Great Britain alone a wide and lucrative field for the inventive ingenuity of mechanical engineers in economising fuel, and especially in the successful application of new methods for dealing with underground haulage, in the inner workings of our collieries, more especially in South Wales, where the number of horses still employed is very large.

Leaving the subject of mining, I may observe that considerable progress has within recent years been made in the mechanical appliances intended to replace horses on our public tram lines. The steam engine now in use in some of our towns has its drawbacks as well as its good qualities, as also has the endless-rope haulauge, and in the case of the latter system, anxiety must be felt when the ropes show signs of wear. The electrically-driven trams appear to work well. I have not, however, seen any published data bearing on the relative cost per mile of these several systems, and this information, when obtained, will be of interest.

At the present time, I understand, exhaustive trials are being made with an ammonia gas engine, which it is anticipated will prove both more economical and efficient than horses for tram roads. The gas is said to be produced from the pure ammonia, obtained by distillation from commercial ammonia, and is given off at a pressure varying from 100lb. to 150lb. per square inch. This ammonia is used in specially-constructed engines, and is then exhausted in a tank containing water, which brings it back into its original form of commercial ammonia, ready for redistillation, and, it is stated, with a comparatively small loss.

Much attention in modern times has been given to the relative values of the numerous new explosives which have been introduced for blasting in mines and for other purposes. Sir Frederick Abel is the greatest authority upon this subject. As applied to mining, various experiments have from time to time been made for the purpose of testing how far it would be safe to employ these explosives in the atmosphere of a coal mine without the risk of causing an explosion of fire-damp. A number of these are mainly composed of compounds of nitro-glycerine with aluminous earth. But, whilst the experiments have indicated that, with rare exceptions, they are practically flameless, it is undoubted that one which would be absolutely so, and which could be used with safety in fiery mines, has yet to be produced.

The adoption in our gaseous mines of a flameless explosive, a self-contained electric lamp of moderate weight which will burn without attention for 12 hours, and the general application of water to moisten the dust, are all more or less questions in which the mechanical engineer is interested, and, when adopted, will probably have the effect of putting an end to the disastrous explosions accompanied by loss of life which occurs at intervals in our fiery collieries, and I trust that the deliberations of this section may result in the practical adoption of steps to secure this desirable object.

In conclusion, as an inhabitant of Cardiff, I may be permitted to congratulate this port on this the first visit of the British Association. Its rising importance is becoming generally recognised, and since the last visit of the British Association to the Principality material progress has been made. Lord Bute has constructed a large dock of 33 acres at Cardiff, and a still larger dock of nearly 70 acres has been constructed at Barry within the port of Cardiff. The tonnage of shipping cleared at the port has increased during the past 11 years 91 per cent. Various new industries have been established here, notably, the manufacture of hematite iron for steel making, on a large scale, by the Dowlais Iron Company; and the exportation of coal has increased from 5,862,349 tons in 1880 to 12,250,652 tons in 1890, or 109 per cent. At Swansea the manufacture of tin-plates, which is one of the leading industries of the western part of this country, has increased from 25,343 tons to 229,791 tons in 1890; and the trade at the neighbouring port of Newport has also materially developed, all showing a rapid progressive development of the large resources of South Wales.

I trust that only a short interval will elapse before we are honoured with another visit of the British Association, and that it will be the good fortune of the president who may have the honour of occupying this chair on that occasion to chronicle similar progress.

GREAT YARMOUTH.

THE BOROUGH SURVEYOR'S REPORT.

The following report to the Yarmouth Town Council upon the electric lighting of the town by the borough surveyor, was submitted by the Electric Lighting Committee at the last monthly meeting:

"Gentlemen,—In accordance with your instructions I submit the following report on the above subject. Since my last report in October, 1889, much has been done to develop this industry, and manufacturers of electric lighting plant have been extremely busy, but few of the towns obtaining a provisional order at the same time as yourselves are much further advanced than you are in carrying out the work for which they have obtained the powers. I will, however, ascertain if you wish it at your next meeting what each has done. I have taken this subject up as a special matter for study, that I might be prepared should I be called upon by you either to design your installation or ultimately to superintend the working of it when the same should be completed, and the information now before me is so great that the difficulties of framing this report consists in condensing the information within the limits which you will have patience to consider. Cost.—A great deal has been written on the subject of the comparative cost of gas and electricity, and the figures which I gave you, and the statements made in my last report referred to above, have been fully borne out—viz., that, light for light, the cost of electricity was about equal to gas at 3s. 3d. per 1,000 cubic feet, but I must remind you that the public have been led to expect such a brilliant light from electricity that an electric lamp of only the same power as an ordinary gas lamp would not be considered satisfactory. Recently, at the annual meeting of the Incorporated Association of Municipal and Sanitary Engineers I had the privilege of listening to an address on the comparative cost of electricity and gas by W. H. Preece, Esq., F.R.S., electrical adviser to the Post Office authorities, and he, after describing the quantities of electricity and gas obtainable from the same quantity of coal, and other technical matters, stated that 'the average amount, taking the return from the nine chief towns of this country, paid per gas-burner per annum is 9s., the average price of gas being 3s. per 1,000 cubic feet; the average amount per lamp of the 200,000 electric lamps burning in London is 10s., the average price being 7½d. per Board of Trade unit.' In Manchester Mr. Preece stated that the average price paid per gas lamp was 7s. 6d., and that electricity would cost 8s. 4d. That the post office at Newcastle was lighted by electricity supplied at 4½d. per unit, with a discount of 20 per cent., which made the cost of electric lighting there very nearly approach that of gas (gas being 2s. per 1,000 cubic feet, with a discount of 10 per cent.). He further stated that at Bolton, Messrs. Horrocks, Crewdson, and Co. had used electric light for six years, the cost per electric lamp being 4s. 0½d. against 5s. 6¾d. per gas burner. Among the advantages of electricity over gas, Mr. Preece called attention to cleanliness, health, security from fire, and the small space which electric lighting works occupied. These statements and all the information I have collected proves that electricity now costs about the same, light for light, as is paid for gas in the town portion of the borough, and the ease and economy with which you are able to obtain the necessary capital to carry out the works should make the supply of electricity a fairly remunerative one to you, should a sufficient number of persons be prepared to lay it in, but I would not advise you to undertake a less installation than 4,000 lights, you yourselves requiring about 1,000 lights for Town Hall, Fish Wharf, Free Library, and Police Station, independently of any public lighting of streets you may undertake. Systems.—A great analogy exists between the distribution of electricity and the supply of water and gas, but there are three ways in which electricity may be applied to central lighting of towns—namely, direct supply, transformer system, and accumulator system. (The report went on to say that electricians are divided in opinion to a very considerable extent on which of the systems are the best for central station lighting.) I am of opinion that either the second or third system could be applied in this town. The second system appears to be the one more favourably received, it being a comparatively simple mode of distributing electricity, but in case of breakdown of machinery the supply would fail, and the machinery must be kept running if only a small number of lights are required. As a rule consumers would not, however, object to the supply being off from midnight until lighting time next day. The advantages of the third system are that the electricity can be stored so that breakdowns in the machinery would make no difference in the lights and electricity can be generated during the day for night use, but the storage batteries would require careful attention. Lighting of Public Streets.—If this is done a portion of the town, such as streets, squares, etc., would have to be lighted with arc lamps, while the narrow streets and rows would be lighted with incandescent lamps. Recommendations.—I would recommend: 1. That information be obtained as to the number of persons in the town willing to guarantee taking a supply from you for a not less term than two years, and what their requirements would be; and that an advertisement be issued in local papers in a similar form to that given at the end of this report. 2. That I obtain the latest information in a tabulated form from each town in which the electric lighting has been adopted, either by the Town Council or by a private company; also from towns which have obtained provisional orders, as to what has been done, the system at work, the results of its working, and general information likely to be of use to you in determining the best course to adopt. 3. That the borough accountant obtain information as to the financial results which have attended the working of the electric light either by private companies or corporations, and report thereon. 4. That a small committee shall be empowered to visit some six or eight towns and inspect the various systems at work with a view to considering the questions of the best system for you to adopt, and the practicability and desirability of lighting the roads and streets with the electric light.—I am, gentlemen, yours obediently, J. W. Cockrill, A.R.I.B.A., A.M.I.C.E., borough surveyor."

On the motion of **Mr. Burton**, seconded by **Mr. Fenner**, it was resolved to recommend the Council to adopt the borough surveyor's four recommendations, and to appoint the following sub-committee to carry out the borough surveyor's fourth recommendation: the chairman, and Messrs. Arnott, Harvey George, and Martins.

Mr. Harvey-George moved the adoption of the report, and

Mr. F. D. Palmer seconded, observing that he would withdraw the motion in his name on the agenda paper, to the effect that it be an instruction to the special committee to proceed with the electric lighting order forthwith, as the committee had taken the course he proposed.

The report was adopted, and, on the motion of **Mr. Harvey-George**, Mr. Palmer was added to the committee.

NEW COMPANIES REGISTERED.

British Electro-Chemical Agency, Limited.—Registered by Bonner, Wright, and Co., Ingram House, 165, Fenchurch-street, E.C., with a capital of £75,000 in £10 shares. Object: to adopt and carry into effect an agreement expressed to be made between the Electric Construction Corporation, Limited, of the one part and this Company of the other part, and to carry on in all its branches the business of electricians and electrical engineers. The first subscribers are:

	Shares.
J. Ebbsmith, Worcester House, Walbrook	1
J. Pender, Thorne Hall, Rugby	1
J. B. Verity, 31, King-street, Covent-garden, W.C.	1
H. C. Mance, Kt., Manova, Newnham-road, Bedford	1
T. Parker, Newbridge, Wolverhampton	1
J. Balfour, Savoy-hill House, W.C.	1
J. S. Balfour, Whitehall-court, S.W.	1

There shall not be less than three nor more than seven Directors. The first shall be Messrs. J. Ebbsmith, J. B. Verity, and J. Balfour. Qualification, £250. Remuneration, £1,000 per annum, with an additional sum of 10 per cent. on the net profits of the Company. Ordinary Directors: When not more than 5 per cent. dividend shall be paid, £150 each per annum; when not more than 10 per cent. dividend, £300 each; and £600 each after payment of 10 per cent. dividend; such remuneration to be divided as the Directors themselves shall determine.

The Electric Installation and Maintenance Company, for the supply of electricity to the Crystal Palace, Sydenham, and district, is a new undertaking with a capital of £100,000, divided into 10,000 £10 shares, of which 626 shares have been already allotted, the present issue being £60,000 in 6,000 shares, 1,124 of which will be allotted as fully paid-up to Messrs. J. E. H. Gordon and Co., Limited, the contractors, in part payment for the works. The Company has obtained a provisional order from the Board of Trade, which has been duly confirmed by Act of Parliament. The objects of the Company will primarily be to supply, by means of electric motors, the power required by exhibitors at the forthcoming Electrical Exhibition at the Crystal Palace in the ensuing winter, and, further, to supply electricity for light and power purposes to the Crystal Palace and district surrounding it.

CITY NOTES.

Brazilian Submarine Telegraph Company.—The receipts for last week amounted to £4,261.

City and South London Railway.—The receipts for the week ending 15th inst. were £653, against £821 for the week ending 8th inst.

Western and Brazilian Telegraph Company.—The receipts for the week ending August 14, after deducting 17 per cent. of the gross receipts payable to the London-Platino Brazilian Telegraph Company, were £2,835.

PROVISIONAL PATENTS, 1891.

August 10.

13503. **Improvements in electric machines and apparatuses for differential phase alternating currents.** Michael von Dolivo-Dobrowolsky and the Company Allgemeine Elektricitäts Gesellschaft, 47, Lincoln's-inn-fields, London. (Complete specification.)

13465. **Improvements in electrical automatic stopping apparatus for weft pile cutting machines.** William Gadd and Oscar Drey, 64, Barton-arcade, Manchester.

13492 **A method and apparatus for electrical propulsion of vehicles.** Francis Edward Elmore, 28, Southampton-buildings, London.

August 11.

13528. **Improved electric time-registering apparatus for use in cabs and the like.** Arthur Douglas, 13, Southampton-street, King's Cross, London.

13529 **Improvements in methods and apparatus for obtaining and utilising electric light.** James Alfred Briggs, 8, Rockley-road, Shepherd's Bush, London.

13553. **Improvements in electrically heated ovens.** Willis Mitchell, 115, Cannon-street, London. (Complete specification.)

13554. **Improvements in electric steam generators.** Willis Mitchell, 115, Cannon-street, London. (Complete specification.)

13558. **Improvements in unipolar continuous-current magneto or dynamo-electric machines.** Jules Cauderay, 24, Southampton-buildings, London.

August 12.

13589. **Improvements in electric conductors.** Georg Eduard Heyl, 38, Alexander-street, Berlin, C., Germany.

13627. **An improved alternating electric current motor.** William Blanch Brain and Arthur James Arnot, 46, Lincoln's-inn-fields, London. (Complete specification.)

August 13.

13628. **Improvements in dynamos for generating electricity.** Wilson Hartnell, Benson's-building, Park-row, Leeds.

August 14.

13692. **Improvements in electric arc lamps.** Arthur Hood Mitchel-Jones, 70, Market-street, Manchester.

13705. **An improved coupling for connecting electric wires.** Alexander Shiels, 70, Wellington-street, Glasgow.

13714. **Improvements in and relating to apparatus for measuring electric currents.** Herbert Woodville Miller, 2, York-mansions, Earl's Court, London.

13753. **Improvements in telegraphic call-boxes.** Alexander Melville Clark, 53, Chancery-lane, London (Joseph Gillis Noyes, United States.) (Complete specification.)

August 15.

13802. **Improved electric current generator for ordinary and multiple-phase alternating currents.** Johannes Sohlman, 28, Southampton-buildings, London.

13809 **New or improved machinery for covering wire conductors with leather.** George Hughes, 38, Chancery-lane, London (Emile Edward Legrand, France.) (Complete specification.)

SPECIFICATIONS PUBLISHED.

1890.

13845. **Propelling tramway vehicles, etc., by electricity** Huber and Magee. 8d.

13987. **Electricity counter.** Richard and others. 8d.

14992. **Electrical conductors.** Hawtayne. 4d.

15250. **Electric circuit connections.** South. 8d.

15252. **Incandescent electric lamps.** South. 8d.

20712. **Electric batteries.** Ortelli. 8d.

1891.

2219. **Electric arc lamps.** Lever. 8d.

6276. **Electric cars.** Blanchard. 6d.

8941. **Electrical hardening, etc.** Boult (Riess). 11d.

9762. **Secondary batteries.** Currie 8d.

10695. **Heating metal bars by electricity.** Angel. 8d.

10697. **Dynamo-electric generators, etc.** Lake (The Thomson Houston International Electric Company). 8d.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Brush Co.	—	2¼
— Pref.	—	1½
India Rubber, Gutta Percha & Telegraph Co.	10	19½
House-to-House	5	5
Metropolitan Electric Supply	—	10
London Electric Supply	5	1⅝
Swan United	3¾	4½
St. James'	—	6¾
National Telephone	5	4¾
Electric Construction	10	7¼
Westminster Electric	—	5

NOTES.

Prague.—The electric railway to the Baumgarten commenced running on July 18.

Electric Cars.—It is stated that there are now over 00 electric cars running regularly in the city of Boston U.S.).

Chicago is to have an underground railway, and a ompany with a capital of 10 million dollars has been ormed to carry out the work.

Electric Railways.—A practical treatise on "Electric Railways and their Working," is in preparation by Dr. Louis Bell and Mr. O. T. Crosby.

Whitechapel. — The Whitechapel Vestry, having determined to obtain their own provisional order, have instructed their clerk to take the necessary proceedings.

Personal.—Mr. J. T. Niblett, recently with Mr. Pitkin, has joined the Mining and General Lamp Company (who own the FitzGerald lithanode patents) as general manager.

British Association.—The new president-elect of the British Association is to be Sir Archibald Geikie. The meeting is to be held in Edinburgh, commencing 3rd August.

Early Telegraph Companies.—The well-known financial paper the *Oracle* is publishing a series of very interesting articles on the early financial and commercial history of the Atlantic telegraph companies.

Appointment.—Mr. T. Smith, five years engaged at Messrs. Immisch's works at Kentish Town, has been appointed secretary to the General Electric Traction Company, which position was rendered vacant by the sad death of Mr. Mackenzie.

Lowestoft.—The town clerk of Lowestoft has been instructed to report to the Town Council as to the cost of obtaining a provisional order under the Electric Lighting Acts; and also as to the charges made for electric current in other towns.

Maidstone.—The Maidstone Local Board are giving their earnest attention to the subject of the electric lighting of the town, and have appointed the Mayor, ex-Mayor, and Alderman Long as a committee to make enquiries as to the proposed provisional order.

Spain.—An electric central station is shortly to be erected at the mill belonging to one of the large capitalists in Aranjuez. A water power of 180 h.p. will be applied to light 31 arc lamps and 600 incandescents. Three Siemens four-pole dynamos are to be used.

City Lighting.—The Board of Trade have given their final consent to the transfer to the City of London Electric Lighting Company, Limited, the provisional orders granted to the Brush Electric Engineering Company, Limited, and the Laing, Wharton, and Down Construction Syndicate, Limited.

Edinburgh.—On Tuesday, at a meeting of the Edinburgh Town Council, a representation was made by the town clerk, submitting the Edinburgh Electric Lighting Order, and craving a remit to the Lord Provost's Committee to consider and report what steps should be taken under the order.

Telephone Wire Struck by Lightning.—In the storm passing over the City on August 19 the telephone wire at 56, Paternoster-row was struck by lightning, which set the bell ringing. The flash was very vivid, and the bell had ceased before the peal of thunder was heard. The time was about 1.43.

Edinburgh.—At Edinburgh Town Council, on Tuesday, a representation by the town clerk, submitting the Edinburgh Electric Lighting Order, was remitted to the Lord Provost's Committee to consider and report what steps should be taken under the order to institute the commencement of electric lighting.

Hissing of the Arc.—In order to suppress the disagreeable noise in the arc, an inventor of the name of Allison has devised the plan of mixing an alkali silicate with the carbon. The evaporation of this as the arc burns forms a conducting vapour which is stated to overcome the inconveniences of hissing.

Electric Motor Outfit.—We notice in an American paper a cut of an electric motor and battery mounted on one stand. Such a thing as this is at once a novelty and useful piece of apparatus that is sure to find favour, and would be worthy of the attention of manufacturing electricians for small sizes of motors.

New Buildings.—Nunwick Hall, near Penrith, is about to be reconstructed for Mr. R. Heywood Thompson, the architect being Mr. Charles J. Ferguson, F.S.A., Carlisle. This should be a favourable time for introducing the "new illuminant." The same with the Armagh Asylum, which is to be added to. Address, Secretary, Board of Control, Dublin.

Bilston.—At the last meeting of the Bilston Town Council, the clerk (Mr. J. D. Wassell) was directed to advertise for tenders for lighting the Market Hall by electricity; also to ascertain from the Bilston Gas Company what sum they would pay the Commissioners for the privilege of lighting the hall, the company to provide all gas fittings.

"Punch" on Electric Lighting.—*Punch* has a vigorous cartoon this week showing a British householder contemplating the imp "Electricity" seated on an indescribable heap of picks, stones, and cables, and holding up his lamp. ELECTRIC LIGHT: "What, won't you let me in—a dear little chap like me?" HOUSEHOLDER: "Ah! You're a little too dear for me—at present."

Utilisation of Water Power.—A company has been formed at Solothurn, with a capital of 800,000f., to construct a canal between the Rivers Emme and Aar: the fall of water so made will be used to drive electric machinery. Two companies have been formed in the Jura for the utilisation of the power of the waterfall "Saut du Doubs" for the electric transmission of power.

Electric Miner's Lamp.—We are glad to learn that the prospect of work in electric miners' lamps is distinctly bright. Several of the larger collieries in the North of England are in negotiation for the extensive introduction of a storage battery lamp, and one colliery owner—subject to a test which the lamps are well calculated to withstand—is understood to have given an order for 600 of these electric miners' lamps.

Gas Engine Storage Cars.—The curious combination of gas engine, dynamo, motor, and storage batteries, all placed on a car, advocated by Mr. W. H. Palton, is stated to have been tried at Pullman "with much success." It seems an absurdity to engineering minds. There is one theoretical advantage, however, that the kinetic or potential energy of the car going down hill can be recovered and stored in the accumulators.

Liverpool Electric Railway.—The electric power for the Liverpool Overhead Electric Railway is, we understand, to be obtained from motors on each car, and not from an electric locomotive. The reason for this is the greater economy of traction, there being plenty of room in the overhead railway for the fitting of motors under the carriages, an arrangement which could not be carried out in the restricted space in the tunnel of the South London line.

Electric Pinnaces.—We are pleased to learn from the General Electric Traction Company that they have received a third order for an electric pinnace from the Russian Government. The field for these electric pinnaces is very extensive, and it is understood that it is intended to fit several ironclads which have already electric light machinery on board entirely with these electric boats. Their use for the large Atlantic liners is also under contemplation.

Mont Blanc Observatory.—M. Imfeld, a Swiss engineer, has been engaged to examine the nature of the summit of Mont Blanc for the construction of M. Jansen's proposed observatory. Tunnels through the ice are being made at a point where it is thought that the ice is not over 40ft. thick. The conditions may be imagined from the fact that, in spite of the coke stoves, the temperature never rises above zero; the ink freezes, and water boils at 83deg. C., so that they cannot properly cook their meals.

The Barmen-Elberfeld Elevated Electric Railway.—It is stated that the difficulties in the way of giving a practical outcome to the projected elevated electric railway from Barmen to Elberfeld appear to have been overcome, as Messrs. Siemens and Halske, of Berlin, have now received instructions to proceed with the construction of the line. The railway will start from Barmen parallel with the River Wupper, which, near Elberfeld, will be spanned by a massive wrought-iron bridge to carry the railway.

New Insulation.—A new insulating material is manufactured by M. E. Legrand, composed of leather cuttings reduced to an impalpable powder, afterwards agglomerated by a special process under considerable pressure. The leather thus treated is no longer spongy, and is absolutely impermeable, having an insulation resistance, according to the *Bulletin International*, of about 1,000 megohms. It is incombustible, and stands the great currents that can be carried by the wires which it covers without melting or burning.

Deep Mining.—It is proposed at Wheeling, Virginia, to bore a hole direct into the earth for 20 miles or so, and 10ft. a day is now being constantly achieved. It is imagined that rich metal will be struck at some point lower down than usual, perhaps melted metals—copper, iron, or even gold and platinum—when the ore would spout up of its own accord without expense of mining. Fear is expressed that they may cause a miniature volcano, but it is more likely that they will strike water or oil before great depth is attained.

Electric Walking-Stick.—The ingenious M. Trouvé has again distinguished himself by the construction of an electric walking-stick, of which the knob consists of a small electric lamp in thick glass bulb, and the battery being two cells of a peculiar shape down the cane itself. The lamp gives sufficient light to read a newspaper in a train, or to light one'self upstairs at night. The genus "masher" will now have a chance to learn something about electrical science, and at the same time greatly amuse, interest, and astonish their friends.

Weymersch Battery.—During the past few months the Weymersch Electric Battery Syndicate, of 2, Victoria-mansions, Westminster, have made considerable improvement in the design of their battery and the method of its application to various technical purposes. They propose giving an exhibition of the capabilities of the battery to-day (Friday) and on Tuesday, 1st September, when the battery may be seen charging accumulators, running a 24in. Blackman fan, and working a Merryweather pump of 12 gallons a minute capacity.

Oil v. Electricity at Helston.—The Town Council of Helston last week appointed a committee to "take all necessary steps forthwith to invite tenders for the lighting of the town with oil lamps in an efficient manner, and, if necessary, on account of urgency, to enter into necessary contracts for carrying out the lighting, avoiding, if possible (in view of electricity in future), the purchase of any oil lamps." The committee were also allowed £10 for the purpose of consulting an electrical engineer as to the probable cost of lighting the streets by electricity.

Cost of Electric Lighting Acts.—We note that at the last meeting of the Edinburgh Town Council, on the representation of the city chamberlain, the sum of £272. 13s. 3d., the cost of the promotion of the Edinburgh Corporation Electric Lighting Order, 1891, was transferred from the general police purposes account to the special account opened in the municipal department for advances of expenses in connection with the promotion of the order. The cost of obtaining a provisional order is often put at from £300 to £400. It will be seen from the above that the cost to the Edinburgh Corporation has been less than the former figure.

Deptford Station.—The statement recently issued that Mr. Ferranti had left the London Electric Company and gone abroad, resolves itself into the fact that the Deptford station now being completed for 100,000 lamps, of which only 30,000 are yet taken up, and the need for economy pressing, the engagement of Mr. Ferranti as chief engineer to the corporation (which was coincident with his post as contractor) has in due course come to an end. Mr. Ferranti is now devoting his whole energies to the development of his business at Charterhouse-square, which has naturally received only a portion of his attention during the great work at Deptford.

Substitute for Platinum.—It was recently announced that Captain Walters, of Vienna, had invented a substitute for platinum for incandescent lamp manufactures. The alloy seems to consist of tin 95 parts and copper five parts by weight, but other ingredients may be employed. It may be mixed with half to 1 per cent. of lead or zinc. The alloy adheres strongly to glass surfaces, and is of the same coefficient expansion as glass—a property hitherto only possessed by platinum, which is of course the cause of the use of this otherwise far too precious metal. The new alloy melts at 360deg. C., and if its promise be carried out should be of the utmost utility in electric lamp manufacture.

Course of Reading.—Dr. Louis Bell, in the *Electrical World*, has a chatty and useful article on a "Course of Electrical Reading." Whilst giving the names of some of the most useful books, he gives also much practical advice. "There is no royal road," he says, "to electrical knowledge, and he who seeks it is bound for continued and exasperating disappointments. The natural tendency is to begin reading special works before the general ones have been mastered, and the result of this, too often, is a sort of half-baked electrician, neither capable of avoiding difficulties nor, what is more important, of extricating himself if he has the misfortune to run foul of them."

British Association Grants.—The British Association have adopted the following money grants, among others, to be appropriated to scientific purposes: Electrical standards (partly renewed), £27; meteorological observations on Ben Nevis, £50; photographs of meteorological phenomena, £15; Pellian equation tables (partly renewed), £15; tables of mathematical functions, £15; electrolysis,

£5 ; discharge of electricity from points, £50 ; seismological phenomena of Japan, £10 ; analysis of iron and steel (renewed), £8. 16s. ; formation of haloids from pure materials (partly renewed), £25. 5s. ; properties of solutions, £10 ; action of light upon dyed colours (partly renewed), £10.

Cork.—Says the *Gas World* : "From what the chairman of the Cork Gas Consumers' Company said to the shareholders at the half yearly meeting last week it is apparent that the directors of the company mean business by their proposal to acquire powers to supply the electric light. We hope they will persevere with the scheme, and so give the gas world generally an opportunity of judging what the prospects are of a gas company being able profitably to supply the electric light. It will be observed that the idea of the directors is to use gas engines for the generation of the electric current. They are fortunate in having a secretary in Mr. Denny Lane who has made a thorough study of both gas engines and the electric light."

Manchester.—The arrangements for supplying the public with the electric light are being rapidly pushed forward by the Electric Lighting Committee of the Manchester Corporation. This committee had a meeting last week, and decided to make certain recommendations to the Gas Committee with reference to the details of the scheme. If the Gas Committee approve the recommendations, then the sanction of the Council will have to be obtained. They recommend, in the first place, that an engineer be appointed to prepare plans and specifications for carrying out the work. The committee do not as yet intend to interfere at all with the existing plan of street lighting; and the electric supply will be for houses, shops, and public buildings generally.

Electrical Accessories.—A company was formed a year or so ago under the name of the Electrical Accessories Company, in connection with Messrs. Drake and Gorham, and has been carried on from the same office. A great many useful and ingenious fittings were designed and manufactured, and a considerable measure of success has been attained, but the definite connection of a manufacturing with a contracting company rather militated against wider extension, and we now learn that the interest of Messrs. Drake and Gorham in the company has now been transferred, with all patterns, models, and patent rights, to the company, which is now entirely distinct. The Electrical Accessories Company will carry on business under the same name, and will shortly remove to another address.

Continuous-Current Transmission at Frankfort.—Besides the alternate-current transmission at Frankfort, the commencement of which we announce elsewhere, an installation of considerable importance has been almost at the same time started from Offenbach to Frankfort by continuous-current transmission. This has been carried out by the Lahmeyer Company, of Frankfort, and consists in the transmission of 100 h.p. a distance of six miles. The current is a continuous one from a drum armature compound-wound dynamo of 2,000 volts, transformed in a secondary dynamo at the exhibition to 70 volts for supplying electric light and motors. The Lahmeyer system of direct-current transformers is patented. The same firm, as already mentioned, exhibits the Haselwander rotary-current motor, besides a distribution of power on a low-tension circuit.

Wynward Park.—A large installation has just been completed by Messrs. Drake and Gorham for the Marquis of Londonderry, comprising upwards of 1,000 lights of different candle-powers. The plant consists of two Davey-Paxman Lancashire boilers, which provide steam for two horizontal compound engines driving two 40-unit dynamos. A smaller Robey engine is also fixed to drive a 15-unit machine, so that a small current may be generated economically. This method of supplying a small plant as an auxiliary to the larger engines has been largely adopted by Messrs. Drake and Gorham in their country house installations, and they find that it effects a considerable economy, as during a considerable portion of the year the number of lights required is but small. The superintendence of the work during erection was carried out by Mr. A. A. Campbell Swinton.

Disappearing Lampposts.—An ingenious suggestion has been made to the Brussels authorities with regard to the electric lighting of their principal streets, and particularly of the Grand' Place, in which the Hôtel de Ville is situated. It has hitherto been objected to the plans for the electrical illumination of this square, that the poles on which the lights were hung, and all proposed improvements in the lamps, were out of harmony with the surrounding architecture, which is of an exceedingly interesting character (many of the buildings being in the old style), and were apt to be an eyesore in the daytime. It is now proposed that the light shall be shed upon the square from tall steel standards, which will be sunk in deep sheaths underground in daylight, and elevated by hydraulic pressure at dusk. Prizes of 1,000f. and 500f. are offered for the best design of lamppost.

An Enormous Microscope.—The Poeller Physical Optical Institute of Munich have under construction an enormous microscope for exhibition at Chicago in 1893. It will magnify to 16,000 diameters, or, as ordinarily fitted, to 11,000 diameters. An electric light of 11,000 c.p. is to be used for illuminating the image, which is to be projected on a screen. As the heat from this powerful light would derange the focus by expansion of the metal, an ingenious device is used to cool the metal. This is a small copper cylinder filled with liquid carbonic acid under a pressure of 350lb. to the square inch. It is connected with the microscope in such a manner that an electric regulator automatically opens a valve and allows a drop of the acid to escape in a spray on the metal to be cooled; the liquid immediately evaporates and produces intense cold. The whole cost of the instrument is said to be nearly £2,000.

High-Tension Continuous-Current System.—A correspondent of the *Times*, writing with reference to the use of high-tension continuous currents, states (apparently officially) that the Electric Installation and Maintenance Company, Limited, are about to supply the Crystal Palace and district with electricity on the system of a high-tension continuous current, with transformers and a reserve of accumulators, and that a similar system is also about being carried out for lighting the city of Oxford. The advantage of the system consists in being able to supply a whole town from one generating station, the low-tension distribution into the houses of consumers available both for light and power being made from small subsidiary stations, working automatically, and with little or no supervision. The first cost of this system is not greater than that of any other, while the cost of working, from the fact of the machinery being always on full load, is very economical.

Ipswich.—The chairman of the Ipswich Lighting Committee last week read a letter from Messrs. R. D. and J. B. Fraser, in which they agreed to erect at their own expense two electric arc lamps and brackets on their premises, each lamp to cost them £30. They also agree to provide electricity, necessary carbons, and attendance, for the said two arc lights of 500 c.p., and keep the same alight during the same hours as the other public lamps, for the next 10 years, if the committee pay £15 per annum. This is a fraction over 1½d. an hour with an average of 10 hours per day. The present lamp and fittings to become Messrs. Fraser's absolute property, as those it is proposed to erect shall be. It was stated that some time since an arrangement was made for one lamp, the first cost of which was £26, and that the present lighting cost £10. 17s. 6d., against the proposed £15; but if two or three other street lamps could be extinguished, for each another £3 would be taken off. It was unanimously agreed to accept Messrs. Fraser's offer.

Growth of Electric Lighting.—Mr. W. H. Massey, writing to the *Times* with reference to the recent articles on the growth of electric lighting in London, says that it is an open secret that some of the existing companies cannot earn a dividend unless the price per Board of Trade unit is raised. The number of incandescent lamps may increase, but there is a decided tendency towards economy amongst the users of them, so that the earning power, so to speak, of each lamp will be steadily reduced; and extensions may lead to actual loss instead of gain to the supply companies. Makers of dynamos, steam engines, and other apparatus are interested in showing the contrary; but the fact is (Mr. Massey adds), nevertheless, as stated. With regard to the relative positions of England and America, he says that when in the United States last winter, he was surprised to find that even then in London alone there were more incandescent lamps than could be heard of in five of their largest cities (including New York) all put together.

Obituary.—We are sorry to have to report the death of Hon. Henry Cecil Raikes, the Postmaster-General of the United Kingdom, at the comparatively early age of 53. Mr. Raikes had long been ill, owing doubtless to the severe strain of Parliamentary Post Office duties, to say nothing of his other commercial work, for he was director in several companies. It was reported that he had been struck by lightning while riding in Hyde Park, and though it is perfectly true he was riding in the park during the thunderstorm, it is by no means certain that he really suffered a shock. It would, indeed, have been too grim that the chief user of electricity in England had suffered from the effects of electric shock. Mr. Raikes only came before the technical world by reason of his position as chief of the Post Office, and it would be idle to deny that considerable friction existed under his rule. He endeavoured to do his duty faithfully to his employer, the Government, and in him they have undoubtedly lost a painstaking and devoted servant.

Willson Dynamos.—*Industries* is sharply taken to task by Mr. Thos. L. Willson—the designer of the immense Willson dynamo for manufacture of aluminium in America—for its description and remarks thereon. In the first place, the output of the machine is 7,500 amperes at 100 volts instead of 15,000 at 50 volts, as incorrectly stated, and the current density is therefore only 2,500 amperes per square inch instead of 5,000 as stated. Again, with regard to Foucault currents, where enormous waste of power and great sparking was expected, Mr. Willson states that the Foucault currents are not a serious matter, as evidenced by the fact that the dynamo gives an efficiency of conversion of over 95 per cent. and runs absolutely without sparking. Where there is only one convolution of armature winding (as in this dynamo) there is minimum of sparking, and, as a fact, he says, the machines run quite sparkless at any load within their limits of capacity. Other little matters are also explained, demonstrating the worthiness of workmanship and design of this dynamo.

South Shields.—The Corporation of South Shields is desirous of receiving proposals from electric lighting companies and others for the laying down, manufacture, supply, and working of the electric light in the borough, in pursuance of the provisional order granted by the Board of Trade to the Corporation, and which has recently received the Royal assent. The Corporation is authorised to lay down distributing mains within certain streets within a period of two years, and offers are invited for supplying certain streets with electric light, for a term of years and at a price per annum, and with such conditions as may be stated in the proposal, and the tender may contain proposals for supplying the remainder of the town or any parts thereof. Proposals to be sealed and sent to Mr. J. M. Moore, town clerk, 35, Market-place, South Shields, by September 16, endorsed "Proposals for Electric Lighting." Any person may obtain a copy of the Act of Parliament confirming the order from Messrs. Eyre and Spottiswoode, printers to the Queen, Fetter-lane, London, E.C.

The Invention of Fuses.—Here is the account of the invention of the fusible strip, as given in the American technical press. Early in November, 1879, Edison had invited a number of prominent men to see his three-wire system and the carbon filament. Someone asked, "What would happen if anyone put a bar of metal across the wires?" "It would short-circuit the whole business, and the thing would be a fizzle." Edison pondered thereon, saw the importance of the question, especially as some of the guests were known to be not too favourably disposed. Finally he ordered the wire to be cut in several places, and these breaks were connected with little strips of lead, the whole laboratory being kept busy casting strips. To complete the story, it is said that a now well-known electrician did actually suggest the playing of a joke by laying a bar across the wires, to which the assistant assented, the only effect being that two or three lamps went out, but the rest went on as usual. We wonder whether this was the first use of the fusible strip, and more, why he didn't patent it.

Electroculture.—Experiments have been carried out in France, in Lot-et-Garonne, by M. Barat, upon the application of electricity to the culture of potatoes, tomatoes and hemp. A row of hemp, subjected to the influence of the electric current, produced a row of stalks 18in. higher than those not electrified in the same time. A kilogramme (2·2lb.) of potatoes planted in the path of the current produced 21 kilogrammes of very large and healthy tubers, while the unelectrified patches only gave 12½ kilogrammes of medium size. The electrified tomatoes also became ripe some eight days before the others. A curious fact has been remarked by M. Barat in his experiments. If a quantity of manure is near the positive pole, the constituent parts of this manure are transported towards the negative pole, and their effects make themselves felt around a distance of some yards. This would seem to be a fresh proof of the opinion long advanced upon the part played by electricity in the growth of plants, an opinion also adopted by M. Specnew, who has given some attention to these phenomena: this is, that the action of the electric current upon plants seems to consist in the more active dissolution of the organic principles existing in the soil which are thus brought within the reach of the roots.

Electric Welding Company.—We have several times alluded to the fact that a large company was to be floated to work the electric welding patents of Prof. Elihu Thomson. This company, under the name of the Electric Welding Company, has been brought out this week, with a capital of £460,000 in 45,000 ordinary shares, taking 10 per cent. cumulative dividend, and 1,000 founders' shares of £10 each, taking half the profit over 10 per cent. The first issue is of £260,000, one-third of which will be taken by the vendors. The applications close on Saturday. The directors are Sir Geo. Barclay Bruce (Past Pres. I.C.E.), E. Ashmead Bartlett, M.P., Captain A. H. Chapman (Messrs. Clarke, Chapman, and Co.), William F. Gooch, J.P. (Vulcan Iron Works), and Joseph Kincaid, M.I.C.E.; consulting engineer, Sir Frederick Bramwell; office, 2, Tokenhouse-buildings, E.C. We have already commented several times upon the enterprise. It is stated that besides the machine which the London and North-Western Railway Company has running at Crewe, welding plants have been installed or are in course of installation on approbation or exhibit, as follows: One at the Lancashire and Yorkshire Railway Works at Horwich; three at the works of Messrs. Mather and Platt, at Salford; one at the works of the Liverpool Condenser Company, Liverpool; one at the works of Messrs. Clarke, Chapman, and Co., Gateshead; one at Messrs. Dobson and Barlow's, of Bolton; one at Messrs. Stewart and Clydesdale's, at Coatbridge, near Glasgow; one at Sir George Elliott's, at Cardiff; one has been ordered for Palmer's Shipbuilding and Iron Company, Limited, of Jarrow-on-Tyne; and one may be seen in full work at Fanshawe-street, Hoxton.

The Kousmine Diffusion Battery.—The diffusion battery of M. Kousmine has been much used in Russia. By making use of the phenomenon of diffusion, M. Kousmine has succeeded in overcoming the increase in internal resistance of the bichromate of potash battery due to the formation of crystals on the positive electrode. The positive carbon electrode consists of four strips attached to the lid of the battery. The negative zinc electrode consists of a circular grating resting on the bottom of the battery. By means of a funnel a 15deg. Beaumé solution of sulphuric acid is introduced until it just reaches the lower end of the carbon strips. A 6 to 7 per cent. solution of bichromate of potash is next introduced. The two liquids do not mix on account of the great difference in their densities. When the battery is short-circuited it is easy to see that chemical action only takes place close to the lower end of the carbon strips, which are gradually surrounded by a violet ring two or three millimetres deep. Above this region the bichromate solution retains its original colour. The bichromate solution being very weak, the chromic crystals dissolve as soon as they are formed, and the positive electrode is not covered by a deposit as in other batteries. The solution of these crystals, having a greater density than the surrounding liquid, falls to the bottom. The sulphate of zinc also falls to the bottom of the cell, causing more sulphuric acid to rise. A cell having the following dimensions has been tested by a committee of experts: Height, 20 centimetres; diameter, 15 centimetres; surface of zinc, 176 square centimetres; bichromate solution, 6 per cent.; sulphuric acid, 15deg. Beaumé. The committee reported that after having been circuited for 8½ hours on an external resistance of ·32 ohm, and then left on open circuit for 10½ hours, the cell continued to work for 4½ hours, when the circuit was again closed, and that it gave during 13 hours 36 ampere-hours for an expenditure of 48 grammes of zinc.

Gas v. Electricity in Ireland.—Mr. Ross, of Dungannon, president of the North of Ireland Association of Gas Managers, made some pertinent remarks as to electric lighting in the annual address last week at Belfast. He still decried the electric light as the "light of the future" in more than one sense, but seemed to think it a blessing in disguise, and that, in the end, the electric light will be found to have been of service to gas companies rather than the reverse. "On the one hand," said Mr. Ross, "a needed stimulus has been given to the improvement of the apparatus for burning gas; and, on the other hand, there has been created a demand for improved light, which we are in a condition to supply. The residents in large towns and cities especially will no longer be content with the modicum of street lighting which was considered quite satisfactory before the era of electric light experiments. Let the public be made aware that it is the local authorities, and not the gas companies, who are responsible for the street lighting, and that it rests with the former whether it shall be good or defective. The gas companies can supply light to any extent that may be ordered and paid for. No reasonable effort should be spared to secure the goodwill of the general body of consumers. Since writing the above, I observe that the electric light has been introduced into Carlow by Messrs. J. E. H. Gordon and Co. The same company have obtained the contract for lighting Larne; and water is to be the motive power. Of course, we shall have our eyes on Carlow in order to see whether or not it will be more successful than Dundalk. I also notice that the same firm have obtained a contract from the Portadown Town Commissioners to light several of the leading streets in that town. The electric light seems, therefore, to be advancing. Well, be it so. There is room enough for both it and gas, and I am not, and never was, the least doubtful that gas would still 'forge ahead,' and its consumption increase."

Stafford County Asylum.—A complete installation of electrical communication has lately been completed at the County Asylum, Stafford, which with regard to increased facilities for an alarm being given in case of fire and for the purposes of intercommunication between the various officials, will make it one of the foremost institutions in the country. The installation, which has been carried out by Messrs. W. A. Shaw and Co., of Heaton Chapel, near Stockport, electrical engineers, under the superintendence of Mr. Nevett, the resident clerk of works, consists of a system of fire alarm pulls, which are fixed in selected portions of the buildings. One of these being pulled out an alarm is immediately given by the ringing of 11 powerful electric bells, of special manufacture, which continue ringing until the pull is replaced. The position of the alarm is also indicated on six distinct indicators at the principal points of the buildings. In addition to this, the officials and attendants (who are members of the fire brigade) are alarmed separately of the danger by bells fixed near their rooms. There is also a complete telephone system by which the medical superintendent can communicate with the various officials throughout the buildings, and these instruments are arranged for intercommunication between the officials as may be desired. One of Gent and Co.'s inkmarking watchman's clocks, which registers the time when an electric push is pressed by the night watchmen, is also a feature of the installation. This registers from 18 different positions in the building. The work and material is of high quality, much of the latter having been specially manufactured, and from the tests that have been made by Mr. W. H. Cheadle, county surveyor, everything has been found to work satisfactorily and ready for use at any moment when required. The wire is of No. 16 gauge throughout, and upwards of 12 miles has been used in the work. Several false alarms of fire have been given to test the working and to exercise the fire brigade. It is hardly necessary to say how serious an event a fire would be at any institution of this kind, and any effort to minimise the danger of such an occurrence should be encouraged to the highest degree of perfection. Great praise is due to the asylum committee and Dr. Christie, the medical superintendent, for this and many other necessary and important improvements.

THE OERLIKON THREE-PHASE DYNAMOS.

The installation for the transmission of power by alternating rotary current from Lauffen to Frankfort having now become an accomplished fact, the description and illustration of the dynamos used in this installation will be doubly interesting to electrical engineers.

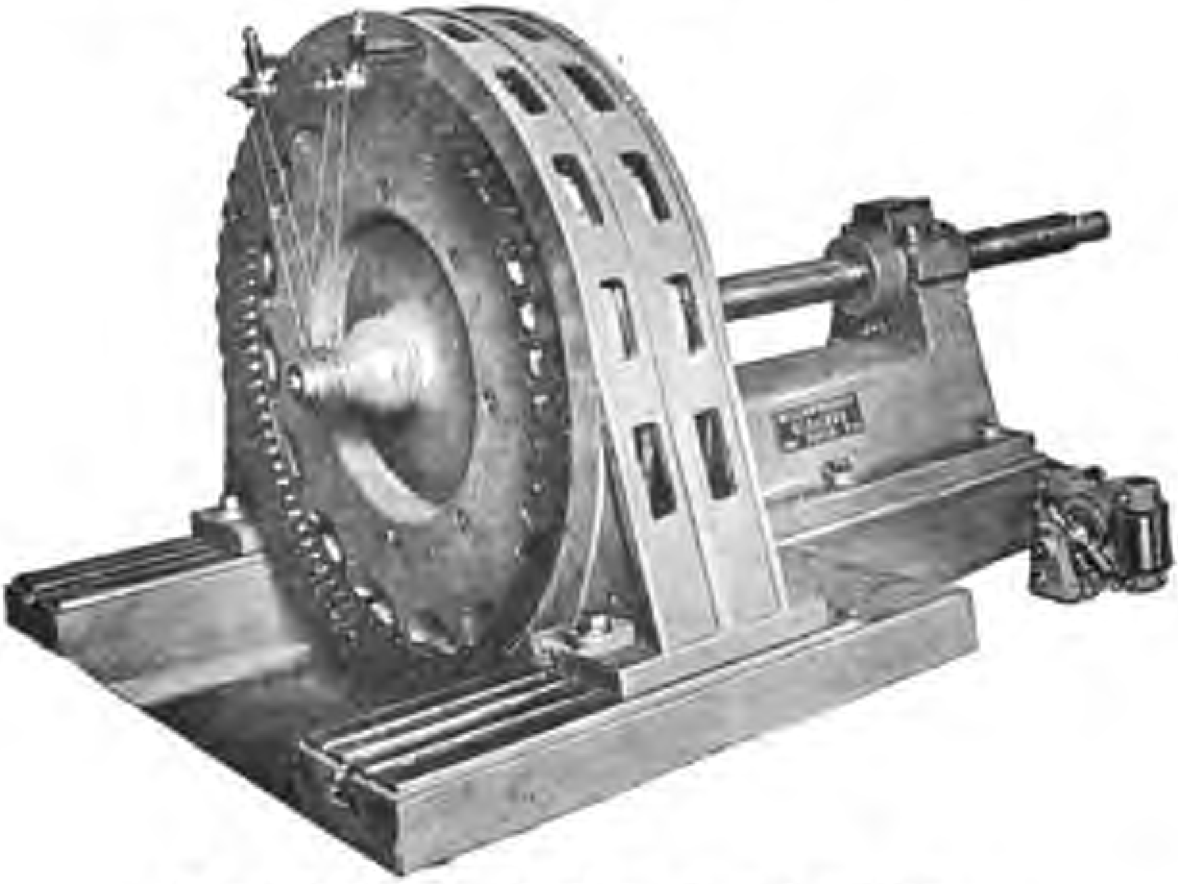


Fig. 1.—Oerlikon Three-Phase Rotary Current Dynamo, General View.

The electric transmission of power by means of electricity has now become an almost every day occurrence, but owing to the great distances by which the waterfalls—the usual sources of natural power—are separated from the centres of distribution, high pressures are necessary to ensure economy in the conductors. The recent invention of the rotary or multiphase system of transmission has enabled this to be done with the greatest degree of economy.

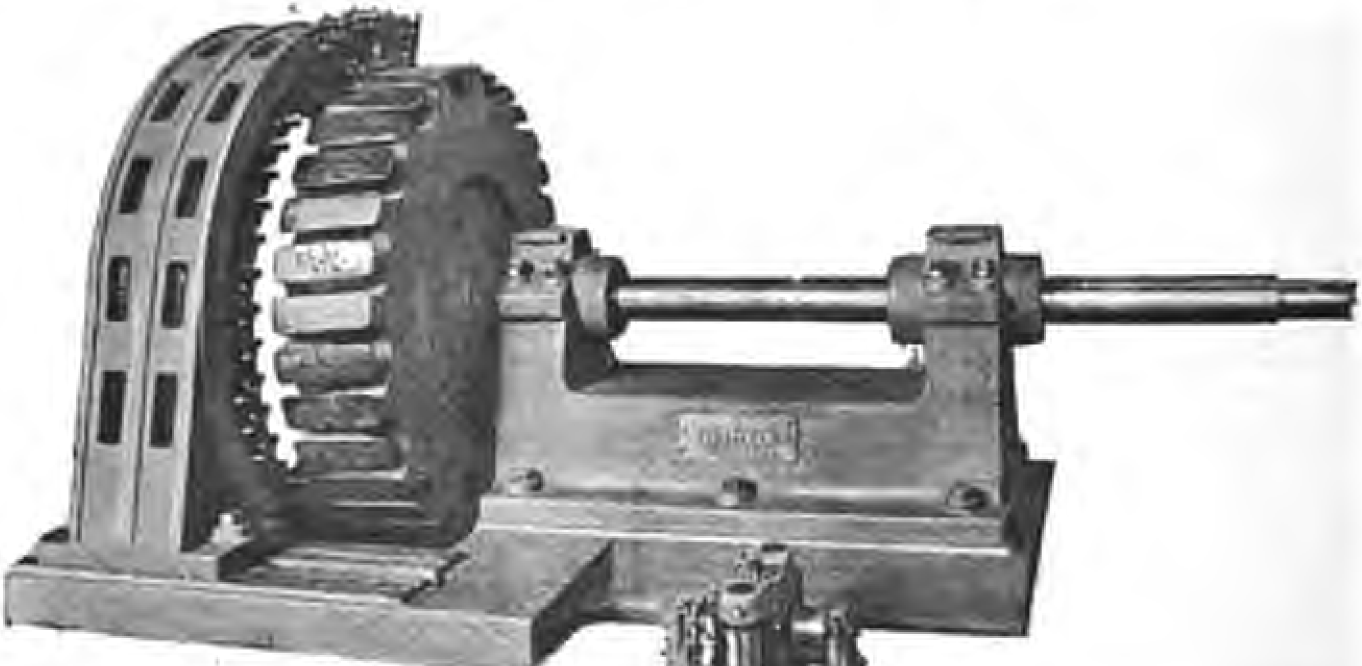


Fig. 2.—Oerlikon Rotary Current Motor, with Field Magnets Withdrawn.

The Oerlikon Works, which, as our readers know, have long made a speciality of transmission of power, besides having just completed the transmission plant at Frankfort for 300 horse-power at 20,000 volts, a distance of 108 miles, have several other plants which they are about to lay down on the multiphase system, with dynamos and motors devised by Mr. C. E. L. Brown, chief engineer of the Oerlikon Works.

A general view of the 300-h.p. multiphase dynamo is seen in Fig. 1. This machine runs at 150 revolutions a minute. The armature circuits are arranged in the way we have already explained to give three separate alternate circuits, whose phases lag behind each other to the extent of 120deg. It must be prevised that the dynamo itself is a low-pressure machine, and the enormous pressures used in transmission are produced from transformation at a special transformer immersed in oil.

Each of the three circuits mentioned is wound for a pressure of 50 volts to give a current of 1,400 amperes. To avoid the difficulties of contacts with such an enormous current, the armature is made stationary, and the field magnets revolve. The conductors in the armature are 29 millimetres in diameter, and consist of massive copper bars, insulated by being slipped inside asbestos tubes, and inserted into holes punched out of the iron periphery. Foucault currents, which would rise to enormous amounts in such large conductors if arranged in the ordinary way, are, by this arrangement, avoided, and, in fact, tests made with these buried conductors even up to 50 millimetres diameter did not show any loss by Foucault currents. This device is mechanically strong, and as asbestos can be used as insulation, an absolutely incombustible armature is obtained. Besides these advantages, the lesser air space required, with consequent reduction of magnetic resistance, enables the exciting current to be considerably decreased.

The field magnets have 32 poles, and correspondingly each circuit of the armature has 32 copper bars, all in series. There being three circuits, there are in all 96 bars on the armature. These three circuits are connected up to each other in the method familiar to electrical engineers in the Thomson-Houston arc dynamo. The core of the armature is surrounded by a frame of cast iron, and the whole can be moved along the bed-plate for repair or cleaning, leaving the field magnet exposed (see Fig. 2).

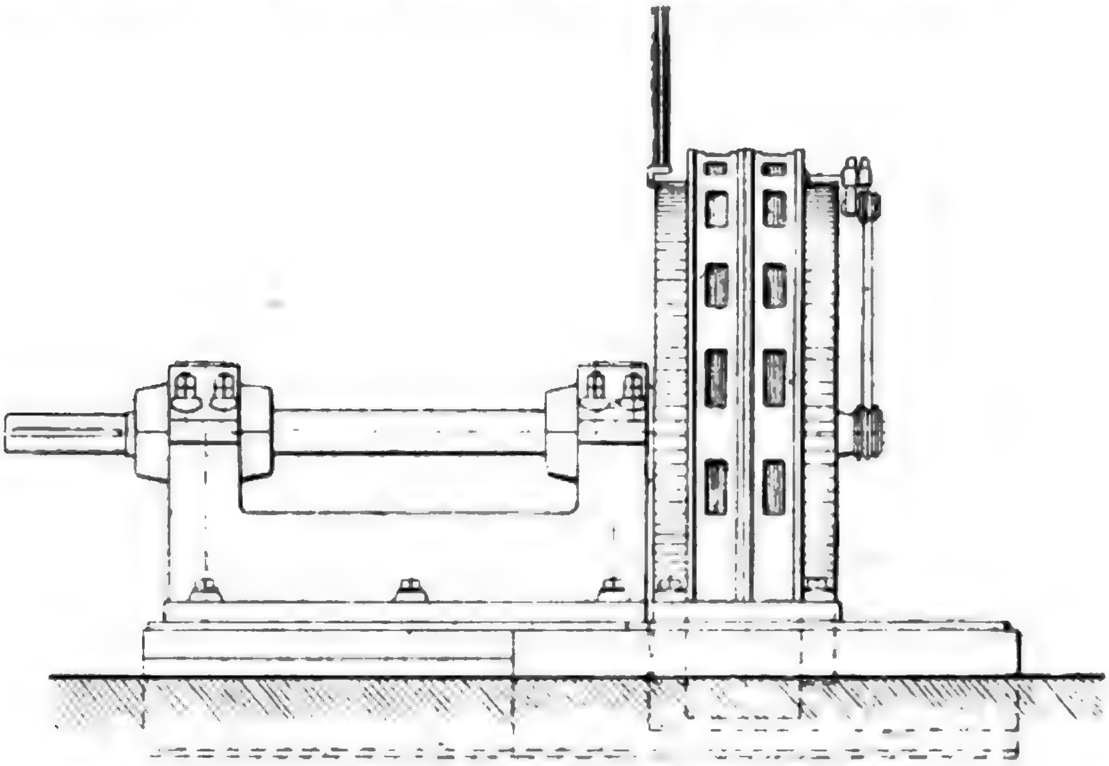


FIG. 3.—Section of Oerlikon Dynamo.

The exciting coils are wound upon a kind of iron wheel, two steel rims, each having 16 projecting teeth forming pole-pieces, are bolted to this pulley, one on each side. This arrangement permits the maximum utilisation of the magnetism, and both the weight of copper and the amount of exciting current are reduced to a minimum. The mechanical construction of this field magnet is simple, the 32 poles being in four parts only—an extreme advantage in a moving mass subject to great strains. The details of the dynamo are shown in plan, section, and elevation in Figs. 3, 4, and 5.

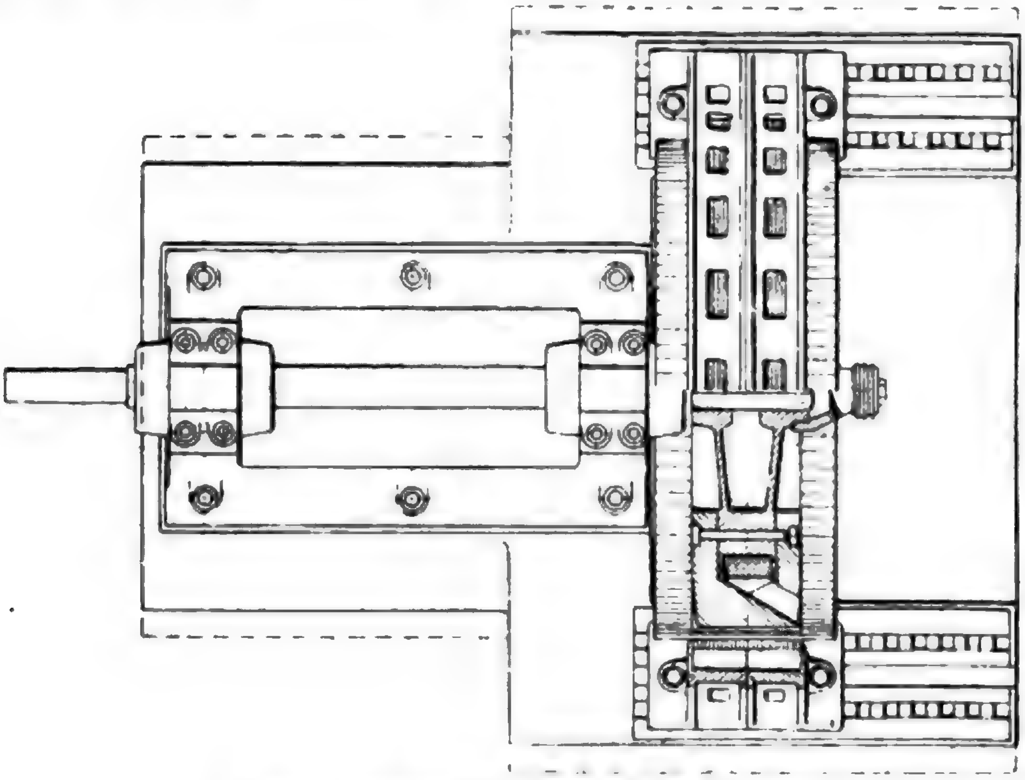


FIG. 4.—Plan and Half Section of Oerlikon Dynamo.

The exciting current is led to the field magnets by two metallic bands, each passing round a grooved ring on the dynamo spindle, round a pulley connected to a terminal, as shown in Fig. 1. The armature has bearings on one side only, the huge spindle being carried on a double bracket bolted, as shown, to the bed-plate.

A dynamo of this type can equally well work as a synchronising motor, but it differs from the synchronising alternate-current motors already devised, inasmuch as it starts without difficulty under load.

The following figures will be read with interest. The total weight of copper on the field magnets is 300 kilogrammes (660lb.), which is only a small proportion of the weight of copper usually required on machines of this size. The exciting current required to give 50 volts on open circuit is only 100 watts—that is, ·05 per cent. of the output. At full load, by reason of the reaction of the armature, this amount is slightly increased, but it never has been found to be more than a fraction of 1 per cent. When running at full speed and at normal pressure, the losses by friction amount to 3,600 watts—about 1·6 or 1·7 per cent. of the maximum output.

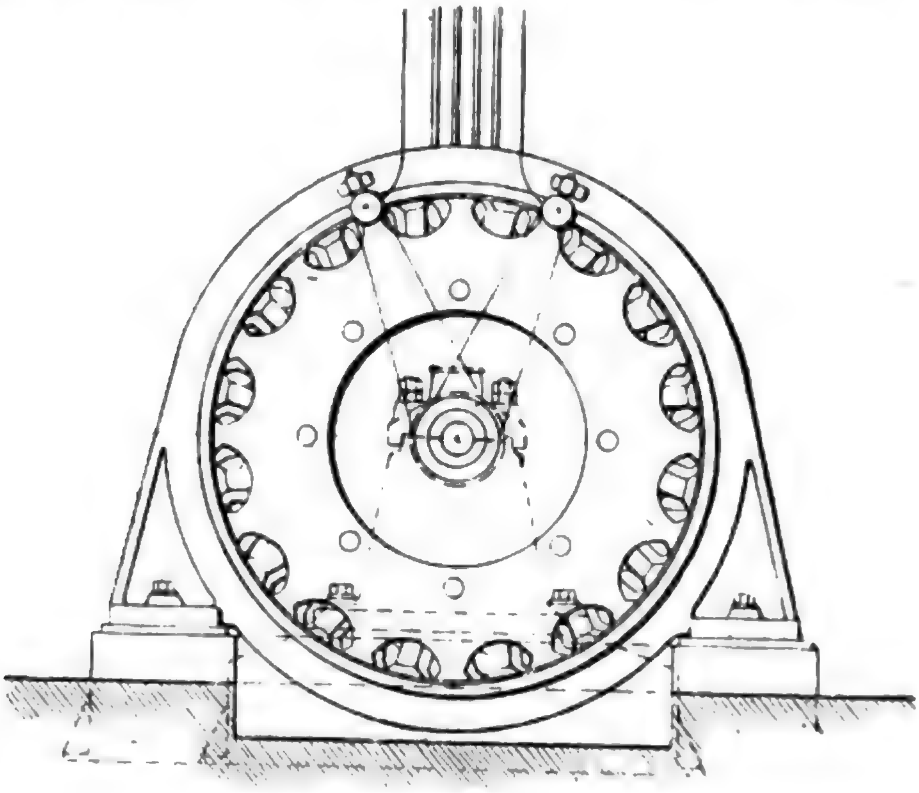


Fig. 5.—Side Elevation of Oerlikon Dynamo.

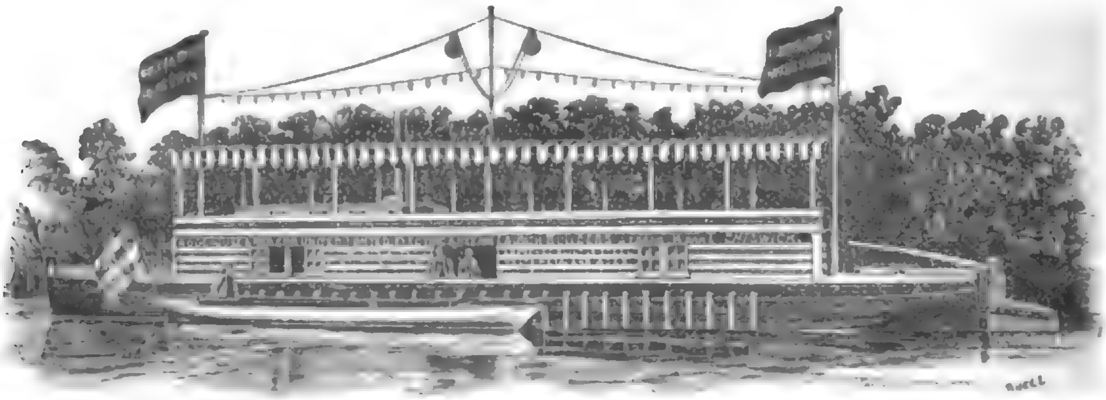
The heating loss (C^2R) in the armature at full load amounts to 3,500 watts. Adding these losses, a commercial efficiency of quite 96 per cent. is obtained, and the losses being so small, the heating is negligible. The total weight without bed-plate is 9,600 kilogrammes (21,120lb., or nearly 10 tons).

Besides the Frankfort transmission plant, the Oerlikon Company have several dynamos of this type under construction. Dynamos are being built for a transmission of power over a distance of six miles at Heilbronn and also at Zurich. Three dynamos with vertical driving axles for conn direct to turbines, and two motors with vertical axes also being constructed for the supply of the whole to their own works at Oerlikon from a waterfal distance of about 12 miles.

FLOATING CHARGING STATION.

The number of electric launches upon the upper of our pretty river is constantly on the increase sight of these craft with their easy motion and noise machinery, apparently cutting their way through water without any effort, and almost without any atten is now fairly familiar to boating-men. They are not to perceive the many advantages of this new mode of pulsion, and we are not surprised to hear that their facture and equipment is taking its place among riverside industries

Messrs. Woodhouse and Rawson United, Limited, Queen Victoria-street, E.C., and Strand Works, Chisw



Woodhouse and Rawson Floating Charging Station.

have devoted much attention to the development of branch of electrical enterprise. Besides building a numb of these launches they have established charging stations Kew, Chertsey, Windsor, and Abingdon, and have recently equipped a floating charging station for attendan at the ever-popular river regattas.

In appearance very similar to a houseboat, the charging station consists of a river barge 80ft. long and 14ft. bea. The machinery is placed in a compartment at one end, consists of a semi-portable steam engine plant and dyna of sufficient output to charge the accumulators on six launches simultaneously. The remaining portion of the boat contains a storeroom, an office, sleeping apartments for the attendants, and an engineer's room, wherein a lathe is fixed, and attendants are kept constantly in readiness to effect any repairs to launches which may be required—a convenience boatowners know how to appreciate.

The charging station also fulfils the duty of supplying any current which may be required for illuminating with the electric light, the numerous houseboats on the river, and at the late Henley Regatta she partly illuminated the course with her arc light.

NEW (CARBONATE OF IRON) FAURE BATTERY.

The following particulars of the new carbonate of iron battery of M. Camille A. Faure are given in the *Bulletin de l'Electricité* for August 20:

The battery is composed of wooden troughs, say, about 27ft. long by 3ft. 9in. high and 6ft. 6in. wide, enclosing some hundred or so double electrodes 6ft. 6in. wide. These electrodes are constituted of an agglomerate of carbon obtained by grinding up in a mill, drying, and then carbonising at 1,400deg. C. a paste composed of quarter by weight of oats, quarter of bituminous coal, and half of very porous clayey earth. An agglomerate is thus obtained which is extremely porous, with which one side of the electrodes only is covered, the other receiving a coating of tar, rendered entirely impermeable by rebaking. The porous side of the electrode is covered with a large piece of netting or coarse sailcloth.

The space between these double electrodes is filled in with granulated iron. The liquid used is salt water led in by tubes. The current is taken from two iron plates at the two extremities; the space between one of the plates and the last electrode is filled in with coke or copper turnings of a sufficient conductivity to carry the current of 1,000 amperes, generated by this battery at a tension of about 1·15 volts.

The elements of iron and carbon immersed in salt water (NaCl) produce chlorate of iron, caustic soda, and hydrogen, with an E.M.F. of about ·30 volt; the hydrogen recombining with the oxygen increases this by ·40 volt, and the carbonisation of the soda by the carbonate of iron adds another ·30 volt, which is again increased ·15 volt by the use of reduced porous iron instead of solid iron. Thus the total E.M.F., according to M. Faure, is:

$$\cdot 30 + \cdot 40 + \cdot 30 + \cdot 15 = 1 \cdot 15 \text{ volts.}$$

In the electrolytic reaction the carbonate of iron and the chlorate of iron form carbonate of iron and chlorate of sodium, which is thus regenerated: the battery only uses the iron transformed into carbonate, which, as will be seen, is easily regenerated, as well as the carbonic acid used for this regeneration.

The cloth-covered porous surfaces constitute the positive faces of the electrodes; they are depolarised by the gases, which penetrate between the faces of each double electrode, which are arranged in cone shape, by holes placed in the bases of this cone, and of which the inert part—the nitrogen—escapes by the porous face, at the same time agitating the liquid.

The reduction of the carbonate of iron takes place in a retort charged with carbonate of iron, and traversed from top to bottom by gas reducers—CO, H, etc.—coming from a gasogene. Passing from the retort, these gases take fire at the contact of air, forming carbonic acid, which passes around the retort to the chimney, whence a portion of the gas is drawn by a pump, which forces it, after washing, into the battery. The air necessary for the combustion of the gasogene arrives, already heated, by a chimney, and the reduced spongy iron passes away cold by a channel placed at the base.

The installation of a Faure primary battery comprises, therefore, besides the battery properly so called—(1,000 elements)—a pump capable of forcing 1,000 cubic metres of carbonic acid per hour, a machine to agglomerate the carbonate of iron passed out of the channels, into bricks, and the reducing chamber.

According to M. Faure, the consumption of fuel in the retort is not more than 0·3lb. of coal per pound of iron used in the battery, or per horse-power hour at the battery terminals.

ON THE ELECTRIFICATION OF STEEL NEEDLE-POINTS IN AIR.[*]

BY A. P. CHATTOCK.

§ 1. As Faraday long ago put it, the discharge of electricity from a point into a gas may be looked upon as a particular case of sparking between a conductor, the point, and a non-conductor, the surrounding gas. It is, moreover, a particularly interesting form of discharge, as compared with that taking place between two conductors, from the fact that it seems more likely to throw light on the unsymmetrical behaviour of positive and negative electricity. For there is evidence which points to the surface of the electrode as the origin of that want of symmetry; and by experimenting with one electrode only, one is able, to a certain extent, to separate its effect on positive electricity from that on negative—such separation being impossible in the case of sparks between two conductors, as both effects are there necessarily present together.

The phenomena connected with discharge from points group themselves naturally under two heads: Those occurring before or at the beginning of discharge, and those occurring during the passage of electricity from the point. What follows refers to the first of these divisions only.

§ 2. When an earth-connected sewing-needle is placed with its end facing the centre of an insulated metal plate, and the latter is gradually electrified, there comes a point at which the needle begins to discharge on to the plate. This point, for given conditions, is very definite, and corresponds to a breaking down of some resistance between the needle and the plate. It seemed desirable to discover how much of the dielectric was concerned in this process. For this purpose measurements were made of the strength of the electrostatic field at the surface of the needle-point at the instant that discharge occurred, the distance of the plate from the needle being varied from 0·04 centimetre to 5 centimetres, while the needle was suspended in such a manner (§ 8) that the attraction between it and the plate could be determined.

Now the attraction is due of course to the tension in the lines of force which end at the surface of the needle; and since their direction is everywhere normal to the surface, it follows that if the needle be a true cylinder placed symmetrically with regard to the plate, the mechanical pulls of the lines of force upon its sides will balance, and the needle will be urged towards the plate with a force which depends only on the lines ending at its point (its other end being shielded from induction). Moreover, so long as the distance from the point to the plate is greater than a few times the diameter of the point, the distribution of electricity on the latter will be practically independent of that distance; and the strength of the electrostatic field just in front of the point will thus come to be proportional to the square root of the mechanical pull on the point. The needle becomes, in fact, its own electrometer, and measures the difference of potential between its point and the air a short distance from it.

In Table I. the value of the square root of the pull, P, in dynes on the point of a fine[†] sewing-needle at the instant of discharge are given for various distances, *d*, in centimetres between its point and a metal plate. The constancy of $\sqrt{P}$ speaks for itself.

It is true that an ordinary sewing-needle is not a perfect cylinder, but tapers gradually to its point, so that part of P must be due to lines of force on its sides; but this must be very small, for the density of charge on the sides is small compared with that at the point, and the force per square centimetre is proportional to the square of the density, and in addition to this the force on the sides has to be resolved into a direction almost at right angles to itself before it can affect P. Indeed, the very constancy of P, when *d* is varied, may be regarded as evidence that this part of P is negligible. (Other reasons are given in § 3.)

The two needles, A and B, on which the measurements were made were numbered alike by the makers, and the agreement in the values of $\sqrt{P}$ for the two is fairly close. This is the more satisfactory as the readings were taken under somewhat different conditions. The needle A was suspended in the larger of the two instruments described in § 8. It discharged on to a disc of tin 13 centimetres in diameter, with its edge protected by a ring of thick wire. The disc and the inside of the instrument were covered with a thin film of vaseline. The readings on B were taken with the small instrument. The disc in this case was a penny with its surface ground and polished. No vaseline was used.

The positive value of $\sqrt{P}$ for the two needles differ by about 3 per cent., whereas the negative values differ by 10 per cent. This is worth pointing out, as it is in accordance with what appears to be a general rule—viz., that the positive discharge is more constant and stable than the negative, and far less independent on the condition of the discharging point.

§ 3. One may, however, go further than simply showing the constancy of the discharge field at the point. In terms of the attraction of the needle and the radius of curvature of the point, it is possible to calculate its value.

Let $d\,a$ represent an element of area of the point's surface, and θ the angle between the direction of the lines of force at $d\,a$ and

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[*] Paper read before the British Association.

[†] Sharp's egg-eyed needles, No. 10.

TABLE I.

Needle A.			Needle B.			
	$\sqrt{P}$.			$\sqrt{P}$.		
d.	+ Discharge.	– Discharge.	*d*.	+ Discharge.	– Discharge.	V.
1·35		1·31	1·57		1·18	20·6
		1·33			1·19	20·7
		1·29		1·58		28·6
		1·31		1·60		28·0
		1·28			1·15	20·4
		1·27			1·17	20·4
		1·26		1·60		28·1
		1·27		1·59		28·0
	1·62		1·08		1·18	17·4
	1·65				1·18	18·0
	1·63			1·61		23·2
		1·26		1·62		23·5
		1·27	0·76		1·17	12·4
		1·26			1·14	12·6
		1·26		1·60		17·3
	1·64			1·59		17·3
	1·64		0·45	1·61		12·3
	1·63			1·60		11·8
	1·64				1·15	8·47
		1·28			1·18	8·89
		1·26	0·28		1·16	7·10
		1·27			1·12	6·73
		1·29		1·53		9·08
3·0		1·27		1·57		9·51
		1·27	0·15	1·59		7·18
		1·28		1·59		7·18
	1·64				1·13	5·36
	1·65				1·15	5·41
	1·65		0·10		1·13	4·63
5·0	1·64				1·17	4·63
	1·66			1·56		6·05
	1·66			1·59		6·27
		1·27	0·04	1·58		5·14
		1·28				
		1·30				
		1·29				
	1·64	1·28		1·59	1·16	

the axis of the needle. Then, if the pull on the needle towards the plate be P,

$$P = \frac{1}{8\pi}\int f^2 \cos\theta \, d\,a$$

over the surface of the point, f being the field strength at $d\,a$.

Take, now, the case of a needle with its point ground to a hemisphere, and assume (what will not be strictly true) that the value of f is uniform all over it (see below). Then the above equation becomes

$$P = \frac{r^2 f^2}{8} \text{ or } f = \frac{\sqrt{8\,P}}{r}$$

where r is the radius of curvature of the point. The average value of $\sqrt{P}$ for positive discharge from needle B (Table I.) is 1·59. That for negative is 1·16. The value of r for so fine a needle is rather uncertain, as it tapers towards the point. Measured under a microscope it seems to lie between $1{\cdot}9 \times 10^{-3}$ and $2{\cdot}3 \times 10^{-3}$ centimetres. Taking the mean of these numbers one obtains the value of the field of force, f, close in front of the point

$$f = \frac{\sqrt{8\,P}}{r} = 2{,}140 \text{ E.S. units for + discharge.}$$

$$= 1{,}560 \quad ,, \quad ,, \quad - \quad ,,$$

The highest measured value of f for discharge in air is, I believe, that obtained by Dr. Liebig for sparks between plates (*Phil. Mag.*, July, 1887, p. 106)—viz., 400 E.S. units for a spark-length of 0·0066 centimetre. This is much less than either of the above numbers, but the length of discharge at the point is probably much less than 0·0066 centimetre. The results may, moreover, be verified by calculation from potential data.

Although the value of f is so large at the surface of the needle-point, the lines of force diverge rapidly, and at a very short distance from the point the field becomes inappreciable. In other words, there occurs within this short distance a step of potential (v) which, if the point is hemispherical and small, may be taken as equal to $\frac{Q}{r}$, where Q is twice the charge on the hemisphere (Q, as already assumed, being uniformly distributed over the point).

In the same way, $f = \frac{Q}{r^2}$, whence

$$v = \frac{Q}{r} = f v = \sqrt{8\,P},$$

its value being thus independent of the somewhat uncertain quantity r.

For needle B,

$$v = 4{\cdot}5 \text{ E.S. units for + discharge.}$$
$$= 3{\cdot}3 \quad ,, \quad ,, \quad - \quad ,,$$

In order to verify the above values of f, it will be convenient and sufficient to show that these values of v calculated from P are in agreement with those calculated from potential measurements.

The column headed V, in Table I., gives the difference of potential in E.S. units between the needle and the plate. Now, except for the presence of the needle itself, the field of force in which it was placed would have consisted of parallel lines; for the point of the needle was arranged in this experiment to project three or four millimetres beyond a flat screen of tinfoil through a small hole in it, and the distance from the tinfoil to the disc (a penny) on to which the needle discharged was small compared with the diameter of the disc, so long as the value of d was less, say, than a centimetre. Even with the needle in position, the field would be disturbed for a very small distance only round about the point, on account of the extreme smallness of the latter. Hence V may be regarded as consisting of two parts—one constant (viz., v) and occurring in a small space close to the point; the other proportional to d for small values of d.

Taking the mean of the values of V for each value of d, we obtain the numbers plotted with d in Curves I.* The upper curve is for positive discharge, the lower for negative. Up to a distance of something less than a centimetre from point to plate, the values of V lie very fairly on the straight lines ruled through them. V, a constant, is thus proportional to d; and the values of the constants are of course to be found where the ruled lines cut the axis of V. These points are hardly distinguishable from the values (which are marked by crosses) of the step of potential at the point calculated above from P (viz., 4·5 and 3·3). They show, indeed, a slight tendency to exceed these values; but the agreement is certainly striking, considering the complete independence of the two methods of measurement.

The small amount (3 to 6 per cent.) by which the potential step calculated from V exceeds that calculated from P may be accounted for, I think, by the fact that the lines of force from the needle-point do not diverge quite as rapidly as calculation supposed. The parallel lines of the rest of the field keep them together and so increase the real step of potential at the point without altering P in proportion. To test this point I measured P for a needle of about the same size as B, first suspending it in a parallel field, and then with its point at the centre of curvature of a spherical cup. In the first case, $\sqrt{P}$ was about 3 or 4 per cent. less than in the second: showing, as it seems to me in the light of what follows, that in the parallel field f at the point was nearer the average value of the field through a small distance from the point-surface than in the radial field of the second case; and to about the same amount that the above discrepancy requires.

This accounts, moreover, for the fact that needle B is the only one which does not agree with the results of Table II. Its constant ($f \times r^{0.8}$) being 15·5 at a pressure of 76 centimetres.

As regards the measurement of potential in the above, the electrometer described in § 8 was used; its constant being determined by comparison with short sparks between brass knobs of 5·3 centimetres diameter.

The following are the readings taken:

Spark length.		V from spark-length (E.S. unit).	$\sqrt{\text{Electrometer reading}}$.	Constant of electrometer.
Observed.	Corrected for flat plates.			
0·127	0·125	17·8	6·63	2·69
,,	,,	,,	6·63	2·69
0·190	0·186	24·8	9·23	2·68
,,	,,	,,	9·39	2·67

The values of V were taken from Dr. Liebig's paper already referred to.

I think, then, it may be safely concluded that the attraction of a plate on a needle-point is practically due *only* to the lines of force ending at this point, even when the needle is not a perfect cylinder; for a conical point could only have the effect of increasing P and so making the step of potential calculated from it bigger than that from V, whereas the reverse is the case. It is true that the density must be greater at the centre of the point than at the sides of the hemisphere. But this is what P chiefly depends upon, and it is also precisely here that discharge occurs and the value of f is required. Hence the connection established above between P and f seems to be practically true, although the assumption that f is uniform over the point-surface is not.

In what follows, therefore, the values of f have in every case been determined from P and r.

Effect of Curvature of Discharging Surface.

§ 4. Two conclusions appear, then, to result from the foregoing. In the first place, the absence of discharge below a certain definite potential, which is constant for given conditions, implies the breaking down of some resistance before electricity can pass off at a point; and, secondly, the fact that f is independent of d points to the near neighbourhood or actual surface of the point as the seat of this resistance.

All this is in accordance with what is known regarding the discharge of electricity in gases, and is indeed only what one would naturally have expected. It still remains to consider whether the resistance to discharge is to be sought in the gas itself, in the surface of the point, or in both.

---

* These curves may appear when Mr. Chattock's paper is published in the *Phil. Mag.* They were not shown at the British Association Meeting.

TABLE II.

eedle.	r.	f.				$f \times r^{0·8}$.			
		(+) $p = 76$	(+) $p = 40$	(+) $p = 20$	(−) $p = 20$	(+) $p = 76$	(+) $p = 40$	(+) $p = 20$	(−) $p = 20$
....	$0·7 \times 10^{-3}$	?6,350	?5,200	?4,600	?3,390	[19·0]	[15·6]	[13·8]	[10·1]
....	1·6 ,,	2,850	2,180	1,700	1,200	16·4	12·6	9·8	6·9
....	1·88 ,,	2,450	1,900	1,500	1,050	16·1	12·5	9·8	6·9
....	4·03 ,,	1,400	1,030	810	580	17·0	12·5	9·8	7·0
....	4·84 ,,	1,180	870	643	510	16·6	12·2	9·0	7·1
....	6·52 ,,	935	680	518	405	16 6	12·1	9·2	7·2
....	7·11 ,,	890	630	470	380	17·0	12·1	9·0	7·3
....	7·83 ,,	800	585	450	360	16·5	12·1	9·3	7·4
....	8·71 ,,	780	560	425	320	17·5	12·6	9·5	7·2
....	10·9 ,,	648	450	325	290	17·4	12·1	8·8	7·8
1	31·8 ,,	335	227	152	140	21·2	14·4	9·6	8·8
....	45·7 ,,	308	198	130	138	26·1	16·8	11·0	11·7
....	58·0 ,,	302	194	132	140	30·9	19·9	13·5	18·0

In Curve IV., r is plotted with f at 76 centimetres pressure from this table.

The possible ways in which resistance may arise are, I think, all be included under three heads :

a) It may exist in the gas itself, to a greater than molecular itance from the point. For this the gas must become possessed something in the nature of structure round about the point—, cease to be gas in the ordinary sense of the word—and the ly kind of structure that suggests itself as likely is that of the larised Grotthuss chains, which Prof. J. J. Thomson has used th such effect in his beautiful theory of striæ.

b) It may exist at the surface of the metal only, and consist in o tearing away from the point by electrical force of electrified rticles which are clinging to it (a special case of which is the cing of charged particles through a non-conducting layer on the int.

(c) Or it may mean the pulling off of something in the nature of ilm possessing surface-tension.

As a matter of fact (b) and (c) are two opposite extremes of the me phenomenon. In both, particles adhering to the point are alled off, but the adhesion of (b) is normal to the surface only—., between the particles and the metal—while in (c) it is ngential to the surface only—i.e., between the particles themlves. An actual case would lie somewhere between the two, and obably much nearer to (b) than to (c).

Now in the case (a) of Grotthuss chains the field, f, at the point, measured by the pull upon it, should increase as the sharpness the point increases; and for two reasons. In the first place, r chains of given length there will be some average strength of eld required to break them, the value of which will always be ss than that measured at the surface of the point on account of e divergence of the lines of force there; and the difference etween the measured and the average field will be more marked s the divergence—i.e., the sharpness of the point—increases. econdly, the chains will be shorter at a sharp point than at a lunt one on account of this same divergence; and this again ill necessitate a stronger field to break them, for much the same eason that a short piece of iron is harder to magnetise than a ong one.

The same sort of variation of f with sharpness of point will ccur in the case of (c), if the mechanical pull of the field on the oint-surface be looked on as having to tear off a film stretched ver it.

But to pull small particles off a point whose radius of curvature s large compared with their diameters will always require the ame value of f. Hence (b) differs from (a) and (c) in requiring hat f shall be independent of r.

The effect on f of altering r was therefore investigated. Steel needles were ground by a watchmaker to hemispherical points of different diameters and burnished with a hard steel-tool. The values of f in air were then determined for each at various pressures; the instrument used being the smaller of the two described in § 8. Curves connecting air-pressure, p, and f were then plotted, and from these the numbers given in Table II. were taken. The values of f for positive discharge are given for three pressures—76, 40, and 20 centimetres of mercury. Those for negative discharge are only given as 20 centimetres. The reason being that the latter show a good deal of irregularity at higher pressures, seeming, as will be seen later, to depend largely on the condition of the point-surface, which the positive values do not. The values of f for needle C are inserted with queries, as they are almost certainly too high. The extreme fineness of its point necessitated a very rapid tapering to the sharpest part, so that a good deal of the measured pull must have been due to lines of force starting from its sides. This is borne out by the numbers in the four last columns.

Now, these columns show that below a point radius of $\frac{1}{10}$ millimetre f varies in close proportion with $r^{-0·8}$, and they consequently negative hypothesis (b). But they also negative (c), for the pull per square centimetre normal to a film of surface-tension, T, and radius of curvature r necessary to break it is proportional to T/r, and if this pull is to be supplied by f it follows that f^2 must be proportional to T/r, which gives −0·5 instead of −0·8 as the power of r with which f varies. Even −0·5 is higher than can be assumed, for it is calculated on the supposition that there is no cohesion between the film and the point, and the existence of cohesion would still further reduce the power of r, as tending to bring the film nearer to class (b).

Resistance to discharge at a point is thus to be found in the surrounding gas, and is, therefore, practically reduced to the breaking down of Grotthuss chains, the length of which are not negligible compared with the radius of curvature of the point. I do not mean by this to exclude surface-resistance as a possible factor in discharge—indeed, what follows shows that it may be very appreciable; but it is not the whole, nor, I believe, an important part, of the resistance at a clean point.

§ 5. After a point has been used for discharge for some time its resistance increases greatly, and when discharge occurs it begins with a suddenness and violence which is very suggestive of the bursting of a film. The effect is increased if the point be now reburnished (without regrinding), though this process makes it look as if it had never been used. For instance, Curves II. are those connecting the pressures of the air with f for needle H. The continuous curve A B represents f at the commencement of positive discharge, C D being for negative. The readings for these two curves were taken alternately, two at a time, the pressure being gradually increased. They correspond to an unused clean needle. The cloud of points (ʘ for positive and × for negative discharge) was obtained on attempting to repeat the curves, and it was noticeable that each repetition increased the values of f, though the needle was well polished on dry wash-leather and rouge each time. Afterwards the needle was reburnished, and the dotted curves E F (+) and G H (−) obtained, showing a still further increase of f and no less irregularity in its values than before.

The above, therefore, furnishes evidence of the growth of resistance at a point where it is used. That the current does not permanently clear the formation away in getting through is obvious from the readings; but if a reading be taken quickly after another with a point in this condition, the second value of f is often slightly lower than the first; as if the film had not had time to finish forming again after the first discharge. Now if this were so it would follow that the value of f, when the current stops, should be less than when it starts (for a used point only; the two values agree closely for a clean one). To test this, needle H was again taken and the values of f determined for various air-pressures at the point when the current just stopped, the potential of the needle being gradually diminished until a high-resistance (7,000 ω) Elliot galvanometer between the needle and the earth stood at zero. The results are given in Curves III. A B and C D for the unused point are repeated from Curves II. for comparison. J K and L M are the new curves. They are marked by circles. The agreement between J K and A B could not be closer, and points unmistakably to a *temporary* cleaning of the point while current is flowing. L M, for negative discharge, is very curious—coinciding as it does with C D at low pressures, while it leaves it so completely higher up. It was noticeable that just in proportion as the two curves diverged, the stoppage of the current was marked by increasing suddenness. At high pressures it was impossible to get the needle to discharge at all with a small current; either the flow was strong or it stopped altogether with a jerk—the same effect, though almost microscopic, being just perceptible at the cessation of positive discharge also. This being so, it follows that the values of f on the negative curve really correspond to a strong current and not to the point where the current stops. Hence their greater values. The sudden cutting off of the negative current was very striking, and suggested rather forcibly the covering over of the point by some sort of film that had been perforated by it. It is true that the positive discharge was hardly affected, but this is only an example of what has been already alluded to—the relatively greater instability of negative than of positive discharge.

(To be continued.)

THE

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We may occasionally follow the lead of our American Contemporaries, especially when they point out a serviceable way. They are not backward in asking their friends to do all they can for the welfare of the paper. We ask our friends to remember us. No Paper that we know ever refuses Subscribers or Advertisers. Nor do we; in fact, we invite them, believing that they will get full value for their money.

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THE B. A.—CARDIFF MEETING.

The general opinion of the Cardiff meeting is unfavourable. Perhaps a good deal of the adverse criticism has been caused by the weather; for a more depressing time it would be hard to conceive, even if it was ordered from Brummagem. The spirits of the excursionists have been much adulterated with water; and this, no doubt, has reacted upon the number of members, the attendance at the sections, and the discussion of papers. People who go through rain to the sectional meetings are less inclined to take a favourable view of the paper under consideration than if bright sunshine and genial weather attended their steps. But with every allowance for bad weather, we imagine it will be admitted that the chaff has been somewhat in excess of the grain at this meeting. Still, there have been some good papers read and discussed. The most important and suggestive, so far as the electrical industry is concerned, was a paper by Mr. A. R. Bennett, read on Tuesday before Section G, describing an electrical exchange system for large towns. It is admitted that in most large towns many streets are congested with traffic, and if some simple means could be found for conveying parcels and small packages it would greatly benefit business people. Mr. Bennett, as we say, put forward a scheme which was admitted by the section to be carefully thought out, though, of course, as Sir F. Bramwell pointed out, its cost and the returns to be obtained determine its practicability. The principal question is, will it pay? and if that is answered satisfactorily, no doubt sooner or later the suggestion so ably put forward will bear good fruit. We shall give this paper complete in due course. While recollection of the meeting is fresh, it may be worth while to call attention to the method of procedure in Section A. Many of the papers are of a highly technical character, and it is difficult to follow the author in the reading. This is especially the case on days when the first paper has been given more than its fair share of time, and other papers following have to be shortened or given in pantomime to get through the programme for the day. The later papers are neither properly read nor adequately discussed, even when suitable for discussion. A very large number of the papers, however, are not at all suited for discussion, yet it is the fashion to pretend to discuss them, and one or more gentlemen who have nothing to say are asked to say sweet nothings in a purely formal manner. The description of experiments, often an interim description of an incomplete investigation, should not be permitted to occupy much time in the section. The aim of the research, with the results obtained, is all that is required to give priority. The wearisome iteration of connections of apparatus is not wanted. A good diagram will give all this without a mass of verbal description. The papers ought to be classified; those requiring no discussion ought to come after those that require discussion. There is a feature of these meetings becoming only too common, and that is a tantalising reference to an incomplete investigation. We are told that the student or professor is engaged upon something wonderful and important, but that at present the work is unfinished. So much time is wasted, and before another year the half-completed experiments, never continued, are forgotten, and the section hears nothing further about them.

A matter more nearly concerning the managers of technical papers rather than their readers might well be considered. Is it impossible, for example, to distribute a complete list of *all* the papers to be brought before the section upon the first morning of the meeting? As things are now managed, it is a purgatorial task to report these technical papers. In fact, they could not and would not be reported at all if authors and secretaries did not hand over the MSS. It often happens, however, that more than one person wants a MS. at the same time, and because of the physical impossibility of several men having the same MS. in different places at the same time, a greater strain is put upon those who have to obtain the copy. If the list of papers was known upon the first day, arrangements could be easily made with authors, and less trouble experienced in this direction. We take it for granted that the association is for the advancement of science, and that authors require publicity for their papers—a publicity, too, not given by a hurried reading before a dozen hearers, and an abstract in the *Proceedings* published six months hence. Section G is by far the best managed as regards this giving of information. The greater part of the abstracts are really ready when the meeting opens, and can be obtained upon application to the secretaries.

The British Association would die of inanition were its proceedings to pass unnoticed for a couple of years. It has no great claim upon the sympathies of the public, and though *conversaziones* and picnics, garden parties and balls, may give the necessary recreation while work is taking its share in the meeting, these social pleasures will not lead to the advancement of science nor keep the association alive. There is a growing dissatisfaction in allowing certain men to act pretty much as they like. Papers from these men—scrappy, unfinished, or finished—are put before better papers of other men. Time is wasted in the murmured congratulations of a mutual admiration society, while through these indulgences time cannot be found for the proper consideration of papers by other men.

That our interpretation of the necessities of the age is the correct one, and that it is the technical press which advances science and not sectional meetings, is proved by the result of the discussion on units held under the joint auspices of Sections A and G. The result really was that every speaker wanted some change or other—hardly any two agreed as to the necessity of any particular change, and it was hoped the technical journals would take the matter up, and by some means so bring affairs to a focus that the Measurement Committee may next year be prepared with a proposal.

If we know aught of the feelings of technical papers, and the ideas of practical men, we imagine they will decline to trouble themselves about the matter. The desire for continued change is not to be commended. Better wait a little than change things too soon, a proceeding which would only necessitate another change almost immediately.

THE ELECTRICAL TRANSMISSION OF POWER AT FRANKFORT.

A Reuter's telegram from Frankfort-on-Main, August 25th, has the following important statement announcing the success of the Frankfort transmission of power—an announcement which may be fairly construed into one of the most eventful occurrences of the nineteenth century: "At noon to-day the electric lamps in the exhibition here were lighted for the first time by the current transmitted from the generating centre at the Lauffen falls of the Neckar, over 100 miles distant from this city. Yesterday the various authorities of Wurtemberg, Baden, Hesse, and Prussia, through whose territory the cable passes, formally took over the undertaking, and subsequently made it over to the General Electricity Company of Berlin and to the Oerlikon Machine Works of Switzerland, the constructors of the plant and electrical appliances. At eight o'clock in the evening the electrical current was transmitted from Lauffen along the cable, and it was found that the precautionary measures adopted along the cable line to ensure the safe transmission of the electric current were perfect. The representatives of the Wurtemberg authorities had assembled at Lauffen itself, the generating centre, while the representatives of the Baden and Hesse authorities, together with Herr von Miller, representing the exhibition, Herr Ebert, representing the Imperial Postal Department, Herr Strecker, the head engineer of the Telegraph Department, Herr von Dobrowolski, representing the electricity company, and Prof. Weber, of the Testing Committee, met at Eberbach, on the confines of Baden and Hesse, where they made some experiments. The transmission of the electrical current, derived from water power over a distance of 108 miles, is therefore an accomplished fact."

We may add that we learn that the voltage has already been run up to 16,000 volts, and the transferred power to over 80 h.p., used to supply 800 incandescent lamps and to drive a motor for pumping water to the artificial waterfall. The cost of the undertaking is given at £40,000.

CORRESPONDENCE.

"One man's word is no man's word
Justice needs that both be heard."

THE ST. PANCRAS EXHIBITION.

SIR,—If you will kindly publish this letter in your next issue we shall be greatly obliged, for although the matter is neither edifying or important, since circulars containing an inaccurate statement concerning us have been printed and distributed, we feel bound to take some notice.

We, in common, we presume, with the rest of the exhibitors of the recent St. Pancras Electrical Exhibition, have received from Mr. Eccleston Gibb, the treasurer, a balance-sheet, accompanied by a circular, concluding thus: "If Messrs. Potter and Joel pay the balance still due from them—viz., £4. 10s.10d.—this will be distributed at a future date."

The facts are as follows: We refused to pay our account in full, pointing out that, owing to the telephone exhibit having been placed in the ante-room which formed the sole means of access to and egress from our stand for the first week of the exhibition (especially during the evenings), visitors were quite unable to reach our exhibit, the throng in the telephone-room being so dense.

Any of the exhibitors will corroborate this, and it was fully recognised at the time by the committee, the telephones being ultimately removed to a corridor on the ground floor.

Needless to say, the success of our exhibit was seriously marred by this blunder on the part of those responsible for the arrangements.

On June 5 last we wrote to Mr. Eccleston Gibb regretting that a question had arisen with reference to our account and enclosing cheque in settlement, which cheque was accepted, and until the receipt of the circular in question we were under the impression that the matter was settled.

We think that the publication of such a statement as that complained of show very questionable taste on the part of Mr. Gibb, or whoever may be responsible, and, in conclusion, we beg to state that we do not for a moment admit that any balance is due from us, nor have we any intention of making any further payment.—Yours, etc.,

Henry F. Joel and Co.

31, Wilson-street, E.C., August 26, 1891.

ELECTRICAL TRADES SECTION.—FRANKFORT EXHIBITION.

Sir,—The sub-committee recommends that gentlemen joining the party in connection with the Electrical Trades Section of the London Chamber of Commerce should travel *viâ* Dover and Ostend, leaving Holborn Viaduct Station by the train at 10 o'clock a.m. on Saturday, the 5th September. Each member of the party should provide himself with the necessary travelling ticket, and it is recommended that such tickets be obtained through Messrs. Cook and Son, Ludgate-circus, E.C., the fare being, *viâ* Dover and Ostend, £5. 16s. first-class return, available 30 days. The ticket should be taken on or before the 2nd September, and in the event of this being done, Messrs. Cook and Son will engage reserved railway carriages between London and Frankfort, and members are requested to specify that they belong to the Electrical Trades Section party. Members are further notified that ladies may be included in the party.

With regard to hotel accommodation the sub-committee could not well engage definitely sufficient rooms beforehand for the entire party, but the committee suggests to members to adhere to the following suggestions, in which case they will no doubt be suited for rooms. They can either buy coupons for rooms and dinners, through Messrs. Cook and Sons, for the Swan Hotel, Frankfort, and if such coupons are taken at the same time as the ticket, Messrs. Cook will take steps to reserve sufficient and good accommodation. Or members of the party can secure rooms at the Britannia Hotel, or Hotel Romscher Kaiser, if they write to the proprietors about a week beforehand, mentioning that they belong the Electrical Trades Section party.

The committee is in communication with the president of the Electro-Technical Society of Frankfort with respect to tickets for the various events in connection with the exhibition and congress, and gentlemen will be advised, if necessary, as to what special arrangements can be made in this respect.—Yours, etc.,

Kenric B. Murray, Secretary.

THE BRITISH ASSOCIATION AT CARDIFF.

PRESIDENTIAL ADDRESS BY WILLIAM HUGGINS, Esq., D.C.L. (Oxon.), LL D. (Cantab., Edin., et Dublin.), Ph.D. (Lugd. Bat.), F.R.S., F.R.A.S., Hon. F.R.S.E., etc., Correspondant de l'Institut de France.

(*Continued from page 186.*)

Prof. Rowland looks to the solar lines which are unaccounted for as a means of enabling him to discover such new terrestrial elements as still lurk in rare minerals and earths, by confronting their spectra directly with that of the sun. He has already resolved yttrium spectroscopically into three components, and actually into two. The comparison of the results of this independent analytical method with the remarkable but different conclusions to which M. Lecoq de Boisbaudran and Mr. Crookes have been led respectively, from spectroscopic observation of these bodies when glowing under molecular bombardment in a vacuum tube, will be awaited with much interest. It is worthy of remark that as our knowledge of the spectrum of hydrogen in its complete form came to us from the stars, it is now from the sun that chemistry is probably about to be enriched by the discovery of new elements.

In a discussion in the Bakerian lecture for 1885 of what we knew up to that time of the sun's corona, I was led to the conclusion that the corona is essentially a phenomenon similar in the cause of its formation to the tails of comets—namely, that it consists for the most part probably of matter going from the sun under the action of a force, possibly electrical, which varies as the surface, and can therefore in the case of highly-attenuated matter easily master the force of gravity even near the sun. Though many of the coronal particles may return to the sun, those which form the long rays or streamers do not return; they separate and soon become too diffused to be any longer visible, and may well go to furnish the matter of the zodiacal light, which otherwise has not received a satisfactory explanation. And further, if such a force exist at the sun, the changes of terrestrial magnetism may be due to direct electric action, as the earth moves through lines of inductive force.

These conclusions appear to be in accordance broadly with the lines along which thought has been directed by the results of subsequent eclipses. Prof. Schuster takes an essentially similar view, and suggests that there may be a direct electric connection between the sun and the planets. He asks further whether the sun may not act like a magnet in consequence of its revolution about its axis. Prof. Bigelow has recently treated the coronal forms by the theory of spherical harmonics, on the supposition that we see phenomena similar to those of free electricity, the rays being lines of force, and the coronal matter discharged from the sun, or at least arranged or controlled by those forces. At the extremities of the streams, for some reasons, the repulsive power may be lost, and gravitation set in, bringing the matter back to the sun. The matter which does leave the sun is persistently transported to the equatorial plane of the corona. In fact, the zodiacal light may be the accumulation at great distances from the sun along this equator of such like material. Photographs on a larger scale will be desirable for the full development of the conclusions which may follow from this study of the curved forms of the coronal structure. Prof. Schaeberle, however, considers that the coronal phenomena may be satisfactorily accounted for on the supposition that the corona is formed of streams of matter ejected mainly from the spot zones with great initial velocities, but smaller than 382 miles a second. Further, that the different types of the corona are due to the effects of perspective on the streams from the earth's place at the time relatively to the plane of the solar equator.

Of the physical and the chemical nature of the coronal matter we know very little. Schuster concludes, from an examination of the eclipses of 1882, 1883, and 1886, that the continuous spectrum of the corona has the maximum of actinic intensity displaced considerably towards the red when compared with the spectrum of the sun, which shows that it can only be due in small part to solar light scattered by small particles. The lines of calcium and of hydrogen do not appear to form part of the normal spectrum of the corona. The green coronal line has no known representative in terrestrial substances, nor has Schuster been able to recognise any of our elements in the other lines of the corona.

The spectra of the stars are almost infinitely diversified, yet they can be arranged with some exceptions in a series in which the adjacent spectra, especially in the photographic region, are scarcely distinguishable, passing from the bluish-white stars, like Sirius, through stars more or less solar in character, to stars with banded spectra, which divide themselves into two apparently independent groups, according as the stronger edge of the bands is towards the red or the blue. In such an arrangement the sun's place is towards the middle of the series.

At present a difference of opinion exists as to the direction in the series in which evolution is proceeding, whether by further condensation white stars pass into the orange and red stages, or whether these more coloured stars are younger and will become white by increasing age. The latter view was suggested by Johnstone Stoney in 1867.

About 10 years ago Ritter, in a series of papers, discussed the behaviour of gaseous masses during condensation, and the probable resulting constitution of the heavenly bodies. According to him a star passes through the orange and red stages twice, first during a comparatively short period of increasing temperature which culminates in the white stage, and a second time during a more prolonged stage of gradual cooling. He suggested that the two groups of banded stars may correspond to these different periods: the young stars being those in which the stronger edge of the dark band is towards the blue, the other banded stars, which are relatively less luminous and few in number, being those which are approaching extinction through age.

Recently, a similar evolutional order has been suggested, which is based upon the hypothesis that the nebulæ and stars consist of colliding meteoric stones in different stages of condensation. More recently the view has been put forward that the diversified spectra of the stars do not represent the stages of an evolutional progress, but are due for the most part to differences of original constitution.

The few minutes which can be given to this part of the address are insufficient for a discussion of these different views. I purpose, therefore, to state briefly, and with reserve as the subject is obscure, some of the considerations from the characters of their spectra which appeared to me to be in favour of the evolutional order in which I arranged the stars from their photographic spectra in 1879. This order is essentially the same as Vogel had previously proposed in his classification of the stars in 1874, in which the white stars, which are most numerous, represent the early adult and most persistent stage of stellar life, the solar condition that of full maturity and of commencing age; while in the orange and red stars with banded spectra we see the setting in and advance of old age. But this statement must be taken broadly, and not as asserting that all stars, however different in mass and possibly to some small extent in original constitution, exhibit one invariable succession of spectra.

In the spectra of the white stars the dark metallic lines are relatively inconspicuous, and occasionally absent, at the same time that the dark lines of hydrogen are usually strong, and more or less broad, upon a continuous spectrum, which is remarkable for its brilliancy at the blue end. In some of these stars the hydrogen and some other lines are bright, and sometimes variable.

As the greater or less prominence of the hydrogen lines, dark or bright, is characteristic of the white stars as a class, and diminishes gradually with the incoming and increase in strength of the other lines, we are probably justified in regarding it as due to some conditions which occur naturally during the progress of stellar life, and not to a peculiarity of original constitution.

To produce a strong absorption spectrum a substance must be at the particular temperature at which it is notably absorptive; and, further, this temperature must be sufficiently below that of the region behind from which the light comes for the gas to appear, so far as its special rays are concerned, as darkness upon it. Considering the high temperature to which hydrogen must be raised before it can show its characteristic emission and absorption, we shall probably be right in attributing the relative feebleness or absence of the other lines, not to the paucity of the metallic vapours, but rather to their being so hot relatively to the substances behind them as to show feebly, if at all, by reversion. Such a state of things would more probably be found, it seems to me, in conditions anterior to the solar stage. A considerable cooling of the sun would probably give rise to banded spectra due to compounds, or to more complex molecules, which might form near the condensing points of the vapours.

The sun and stars are generally regarded as consisting of glowing vapours surrounded by a photosphere where condensation is taking place, the temperature of the photospheric layer from which the greater part of the radiation comes being constantly renewed from the hotter matter within.

At the surface the convection currents would be strong, producing a considerable commotion, by which the different gases would be mixed and not allowed to retain the inequality of proportions at different levels due to their vapour densities.

Now the conditions of the radiating photosphere and those of the gases above it, on which the character of the spectrum of a star depends, will be determined, not only by temperature, but also by the force of gravity in these regions; this force will be fixed by the star's mass and its stage of condensation, and will become greater as the star continues to condense.

In the case of the sun the force of gravity has already become so great at the surface that the decrease of the density of the gases must be extremely rapid, passing in the space of a few miles from atmospheric pressure to a density infinitesimally small; consequently the temperature gradient at the surface, if determined solely by expansion, must be extremely rapid. The gases here, however, are exposed to the fierce radiation of the sun, and unless wholly transparent would take up heat, especially if any solid or liquid particles were present from condensation or convection currents.

From these causes, within a very small extent of space at the surface of the sun, all bodies with which we are acquainted should fall to a condition in which the extremely tenuous gas could no longer give a visible spectrum. The insignificance of the angle subtended by this space as seen from the earth should cause the boundary of the solar atmosphere to appear defined. If the boundary which we see be that of the sun proper, the matter above it will have to be regarded as in an essentially dynamical condition—an assemblage, so to speak, of gaseous projectiles for the most part falling back upon the sun after a greater or less range of flight. But in any case it is within a space of relatively small extent in the sun, and probably in the other solar stars, that the reversion which is manifested by dark lines is to be regarded as taking place.

Passing backward in the star's life, we should find a gradual weakening of gravity at the surface, a reduction of the temperature gradient so far as it was determined by expansion, and convection currents of less violence producing less interference with the proportional quantities of gases due to their vapour densities, while the effects of eruptions would be more extensive.

At last we might come to a state of things in which, if the star were hot enough, only hydrogen might be sufficiently cool relatively to the radiation behind to produce a strong absorption. The lower vapours would be protected, and might continue to be relatively too hot for their lines to appear very dark upon the continuous spectrum; besides, their lines might be possibly to some extent effaced by the coming in under such conditions in the vapours themselves of a continuous spectrum.

In such a star the light radiated towards the upper part of the atmosphere may have come from portions lower down of the atmosphere itself, or at least from parts not greatly hotter. There may be no such great difference of temperature of the low and less low portions of the star's atmosphere as to make the darkening effect of absorption of the protected metallic vapours to prevail over the illuminating effect of their emission.

It is only by a vibratory motion corresponding to a very high temperature that the bright lines of the first spectrum of hydrogen can be brought out, and by the equivalence of absorbing and emitting power that the corresponding spectrum of absorption should be produced; yet for a strong absorption to show itself, the hydrogen must be cool relatively to the source of radiation behind it, whether this be condensed particles or gas. Such conditions, it seems to me, should occur in the earlier rather than in the more advanced stages of condensation.

The subject is obscure, and we may go wrong in our mode of conceiving of the probable progress of events, but there can be no doubt that in one remarkable instance the white-star spectrum is associated with an early stage of condensation.

Sirius is one of the most conspicuous examples of one type of this class of stars. Photometric observations combined with its ascertained parallax show that this star emits from 40 to 60 times the light of the sun, even to the eye, which is insensible to ultra-violet light, in which Sirius is very rich, while we learn from the motion of its companion that its mass is not much more than double that of our sun. It follows that unless we attribute to this star an improbably great emissive power, it must be of immense size, and in a much more diffuse and therefore an earlier condition than our sun; though probably at a later stage than those white stars in which the hydrogen lines are bright.

A direct determination of the relative temperature of the photospheres of the stars might possibly be obtained in some cases from the relative position of maximum radiation of their continuous spectra. Langley has shown that through the whole range of temperature on which we can experiment, and presumably at temperatures beyond, the maximum of radiation power in solid bodies gradually shifts upwards in the spectrum from the infra-red through the red and orange, and that in the sun it has reached the blue.

The defined character as a rule of the stellar lines of absorption suggests that the vapours producing them do not at the same time exert any strong power of general absorption. Consequently we should probably not go far wrong, when the photosphere consists of liquid or solid particles, if we could compare select parts of the continuous spectrum between the stronger lines or where they are fewest. It is obvious that if extended portions of different stellar spectra were compared, their true relation would be obscured by the line-absorption.

The increase of temperature, as shown by the rise in the spectrum of the maximum of radiation, may not always be accompanied by a corresponding greater brightness of a star as estimated by the eye, which is an extremely imperfect photometric instrument. Not only is the eye blind to large regions of radiation, but even for the small range of light that we can see the visual effect varies enormously with its colour. According to Prof. Langley, the same amount of energy which just enables us to perceive light in the crimson at A would in the green produce a visual effect 100,000 times greater. In the violet the proportional effect would be 1,600, in the blue 62,000, in the yellow 28,000, in the orange 14,000, and in the red 1,200. Captain Abney's recent experiments make the sensitiveness of the eye for the green near F to be 750 times greater than for red about C. It is for this reason, at least in part, that I suggested in 1864, and have since shown by direct observation that the spectrum of the nebula in Andromeda, and presumably of similar nebulæ, is in appearance only wanting in the red.

The stage at which the maximum radiation is in the green, corresponding to the eye's greatest sensitiveness, would be that in which it could be most favourably measured by eye photometry. As the maximum rose into the violet and beyond, the star would increase in visual brightness, but not in proportion to the increase of energy radiated by it.

The brightness of a star would be affected by the nature of the substance by which the light was chiefly emitted. In the laboratory solid carbon exhibits the highest emissive power. A stellar stage in which radiation comes, to a large extent, from a photosphere of the solid particles of this substance would be favourable for great brilliancy. Though the stars are built up of matter essentially similar to that of the sun, it does not follow that the proportion of the different elements is everywhere the same. It may be that the substances condensed in the photospheres of different stars may differ in their emissive powers, but probably not to a great extent.

All the heavenly bodies are seen by us through the tinted medium of our atmosphere. According to Langley, the solar stage of stars is not really yellow, but even as gauged by our imperfect eyes, would appear bluish-white if we could free ourselves from the deceptive influences of our surroundings.

From these considerations it follows that we can scarcely infer the evolutional stages of the stars from a simple comparison of their eye-magnitudes. We should expect the white stars to be, as a class, less dense than the stars in the solar stage. As great mass might bring in the solar type of spectrum at a relatively earlier time, some of the brightest of these stars may be very massive and brighter than the sun—for example, the brilliant star Arcturus. For these reasons the solar stars should not only be denser than the white stars, but perhaps, as a class, surpass them in mass and eye-brightness.

It has been shown by Lane that, so long as a condensing gaseous mass remains subject to the laws of a purely gaseous body, its temperature will continue to rise.

The greater or less breadth of the lines of absorption of hydrogen in the white stars may be due to variations of the depth of the hydrogen in the line of sight, arising from the causes which have been discussed. At the sides of the lines the absorption and emission are feebler than in the middle, and would come out more strongly with a greater thickness of gas.

The diversities among the white stars are nearly as numerous as the individuals of the class. Time does not permit me to do more than to record that in addition to the three sub-classes into which they have been divided by Vogel, Scheiner has recently investigated minor differences as suggested by the character of the third line of hydrogen near G. He has pointed out, too, that so far as his observations go the white stars in the constellation of Orion stand alone, with the exception of Algol, in possessing a dark line in the blue which has apparently the same position as a bright line in the great nebula of the same constellation; and Pickering finds in his photographs of the spectra of these stars dark lines corresponding to the principal lines of the bright-line stars, and the planetary nebulæ with the exception of the chief nebular line. The association of white stars with nebular matter in Orion, in the Pleiades, in the region of the Milky Way, and in other parts of the heavens, may be regarded as falling in with the view that I taken.

In the stars possibly further removed from the white class than our sun, belonging to the first division of Vogel's third class, which are distinguished by absorption bands with their stronger edge towards the blue, the hydrogen lines are narrower than in the solar spectrum. In these stars the density-gradient is probably still more rapid, the depth of hydrogen may be less, and possibly the hydrogen molecules may be affected by a larger number of encounters with dissimilar molecules. In some red stars with dark hydrocarbon bands the hydrogen lines have not certainly been observed; if they are really absent, it may be because the temperature has fallen below the point at which hydrogen can exert its characteristic absorption; besides, some hydrogen will have united with the carbon. The coming in of the hydrocarbon bands may indicate a later evolution stage, but the temperature may still be high, as acetylene can exist in the electric arc.

A number of small stars, more or less similar to those which are known by the names of their discoverers, Wolf and Rayet, have been found by Pickering in his photographs. These are remarkable for several brilliant groups of bright lines, including frequently the hydrogen lines and the line D_3, upon a continuous spectrum strong in blue and violet rays, in which are also dark lines of absorption. As some of the bright groups appear in his photographs to agree in position with corresponding bright lines in the planetary nebulæ, Pickering suggests that these stars should be placed in one class with them, but the brightest nebular line is absent from these stars. The simplest conception of their nature would be that each star is surrounded by a nebula, the bright groups being due to gaseous matter outside the star. Mr. Roberts, however, has not been able to bring out any indication of nebulosity by prolonged exposure. The remarkable star η Argus may belong to this class of the heavenly bodies.

In the nebulæ, the elder Herschel saw portions of the fiery mist or "shining fluid" out of which the heavens and the earth had been slowly fashioned. For a time this view of the nebulæ gave place to that which regarded them as external galaxies, cosmical "sandheaps," too remote to be resolved into separate stars; though indeed, in 1858, Mr. Herbert Spencer showed that the observations of nebulæ up to that time were really in favour of an evolutional progress.

In 1864 I brought the spectroscope to bear upon them; the bright lines which flashed upon the eye showed the source of the light to be glowing gas, and so restored these bodies to what is probably their true place, as an early stage of sidereal life.

At that early time our knowledge of stellar spectra was small. For this reason partly, and probably also under the undue influence of theological opinions then widely prevalent, I unwisely wrote in my original paper in 1864, "that in these objects we no longer have to do with a special modification of our own type of sun, but find ourselves in presence of objects possessing a distinct and peculiar plan of structure." Two years later, however, in a lecture before this association, I took a truer position. "Our views of the universe," I said, "are undergoing important changes; let us wait for more facts with minds unfettered by any dogmatic theory, and therefore free to receive the teaching, whatever it may be, of new observations."

Let us turn aside for a moment from the nebulæ in the sky to the conclusions to which philosophers had been irresistibly led by a consideration of the features of the solar system. We have before us in the sun and planets obviously not a haphazard aggregation of bodies, but a system resting upon a multitude of relations pointing to a common physical cause. From these considerations Kant and Laplace formulated the nebular hypothesis, resting it on gravitation alone, for at that time the science of the conservation of energy was practically unknown. These philosophers showed how, on the supposition that the space now occupied by the solar system was once filled by a vaporous mass, the formation of the sun and planets could be reasonably accounted for.

By a totally different method of reasoning, modern science traces the solar system backward, step by step, to a similar state of things at the beginning. According to Helmholtz, the sun's heat is maintained by the contraction of his mass, at the rate of about 220ft. a year. Whether at the present time the sun is getting hotter or colder we do not certainly know. We can reason back to the time when the sun was sufficiently expanded to fill the whole space occupied by the solar system, and was reduced to a great glowing nebula. Though man's life—the life of the race, perhaps—is too short to give us direct evidence of any distinct stages of so august a process, still the probability is great that the nebular hypothesis, especially in the more precise form given to it by Roche, does represent broadly, notwithstanding some difficulties, the succession of events through which the sun and planets have passed.

The nebular hypothesis of Laplace requires a rotating mass of fluid which at successive epochs become unstable from excess of motion and left behind rings—or more probably, perhaps, lumps—of matter from the equatorial regions.

The difficulties to which I have referred have suggested to some thinkers a different view of things, according to which it is not necessary to suppose that one part of the system gravitationally supports another. The whole may consist of a congeries of discrete bodies even if these bodies be the ultimate molecules of matter. The planets may have been formed by the gradual accretion of such discrete bodies. On the view that the material of the condensing solar system consisted of separate particles or masses, we have no longer the fluid pressure which is an essential part of Laplace's theory. Fay, in his theory of evolution from meteorites, has to throw over this fundamental idea of the nebular hypothesis, and he formulates instead a different succession of events in which the outer planets were formed last—a theory which has difficulties of its own.

Prof. George Darwin has recently shown, from an investigation of the mechanical conditions of a swarm of meteorites, that on certain assumptions a meteoric swarm might behave as a coarse gas, and in this way bring back the fluid-pressure exercised by one part of the system on the other, which is required by Laplace's theory. One chief assumption consists in supposing that such inelastic bodies as meteoric stones might attain the effective elasticity of a high order which is necessary to the theory through the sudden volatilisation of a part of their mass at an encounter, by which what is virtually a violent explosive is introduced between the two colliding stones. Prof. Darwin is careful to point out that it must necessarily be obscure as to how a small mass of solid matter can take up a very large amount of energy in a small fraction of a second.

Any direct indications from the heavens themselves, however slight, are of so great value, that I should perhaps in this connection call attention to a recent remarkable photograph by Mr. Roberts of the great nebula in Andromeda. On this plate we seem to have presented to us some stage of cosmical evolution on a gigantic scale. The photograph shows a sort of whirlpool disturbance of the luminous matter which is distributed in a plane inclined to the line of sight, in which a series of rings of bright matter separated by dark spaces, greatly foreshortened by perspective, surround a large undefined central mass. We are ignorant of the parallax of this nebula, but there can be little doubt that we are looking upon a system very remote, and therefore of a magnitude great beyond our power of adequate comprehension. The matter of this nebula, in whatever state it may be, appears to be distributed, as in so many other nebulæ, in rings or spiral streams, and to suggest a stage in a succession of evolutional events not inconsistent with that which the nebular hypothesis requires. To liken this object more directly to any particular stage in the formation of the solar system would be "to compare things great with small," and might be indeed to introduce a false analogy; but on the other hand, we should err through an excess of caution if we did not accept the remarkable features brought to light by this photograph as a presumptive indication of a progress of events in cosmical history following broadly upon the lines of Laplace's theory.

The old view of the original matter of the nebulæ, that it consisted of a "fiery mist,"

"a tumultuous cloud
Instinct with fire and nitre,"

fell at once with the rise of the science of thermodynamics. In 1854 Helmholtz showed that the supposition of an original fiery condition of the nebulous stuff was unnecessary, since in the mutual gravitation of widely-separated matter we have a store of potential energy sufficient to generate the high temperature of the sun and stars. We can scarcely go wrong in attributing the light of the nebulæ to the conversion of the gravitational energy of shrinkage into molecular motion.

The idea that the light of comets and of nebulæ may be due to a succession of ignited flashes of gas from the encounters of meteoric stones was suggested by Prof. Tait, and was brought to the notice of this association in 1871 by Sir William Thomson in his presidential address.

The spectrum of the bright line nebulæ is certainly not such a spectrum as we should expect from the flashing by collisions of meteorites similar to those which have been analysed in our laboratories. The strongest lines of the substances which in the case of such meteorites would first show themselves—iron, sodium, magnesium, nickel, etc.—are not those which distinguish the nebular spectrum. On the contrary, this spectrum is chiefly remarkable for a few brilliant lines, very narrow and defined, upon a background of a faint continuous spectrum, which contains numerous bright lines, and probably some lines of absorption.

The two most conspicuous lines have not been interpreted; for though the second line falls near, it is not coincident with a strong double line of iron. It is hardly necessary to say that though the near position of the brightest line to the bright double line of nitrogen, as seen in a small spectroscope in 1864, naturally suggested at that early time the possibility of the presence of this element in the nebulæ, I have been careful to point out, to prevent misapprehension, that in more recent years the nitrogen line and subsequently a lead line have been employed by me solely as fiducial points of reference in the spectrum.

The third line we know to be the second line of the first spectrum of hydrogen. Mr. Keeler has seen the first hydrogen line in the red, and photographs show that this hydrogen spectrum is probably present in its complete form, or nearly so, as we first learnt to know it in the absorption spectrum of the white stars.

We are not surprised to find associated with it the line D_3, near the position of the absent sodium lines, probably due to the atom of some unknown gas, which in the sun can only show itself in the outbursts of highest temperature, and for this reason does not reveal itself by absorption in the solar spectrum.

It is not unreasonable to assume that the two brightest lines, which are of the same order, are produced by substances of a similar nature, in which a vibratory motion, corresponding to a very high temperature, is also necessary. These substances, as well as that represented by the line D_3, may be possibly some of the unknown elements which are wanting in our terrestrial chemistry between hydrogen and lithium, unless, indeed, D_3 be on the lighter side of hydrogen.

In the laboratory we must have recourse to the electric discharge to bring out the spectrum of hydrogen; but in a vacuum tube, though the radiation may be great, from the relative fewness of the luminous atoms or molecules, or from some other cause, the temperature of the gas as a whole may be low.

On account of the large extent of the nebulæ a comparatively small number of luminous molecules or atoms would probably be sufficient to make the nebulæ as bright as they appear to us. On such an assumption the average temperature may be low, but the individual particles, which by their encounters are luminous, must have motions corresponding to a very high temperature, and in this sense be extremely hot.

In such diffuse masses, from the great mean length of free path, the encounters would be rare but correspondingly violent, and tend to bring about vibrations of comparatively short period, as appears to be the case if we may judge by the great relative brightness of the more refrangible lines of the nebular spectrum.

Such a view may perhaps reconcile the high temperature which the nebular spectrum undoubtedly suggests with the much lower mean temperature of the gaseous mass, which we should expect at so early a stage of condensation, unless we assume a very enormous mass; or that the matter coming together had previously considerable motion, or considerable molecular agitation.

The inquisitiveness of the human mind does not allow us to remain content with the interpretation of the present state of the cosmical masses, but suggests the question—

"What see'st thou else
In the dark backward and abysm of time?"

What was the original state of things? How has it come about that by the side of ageing worlds we have nebulæ in a relatively younger stage? Have any of them received their birth from dark suns, which have collided into new life, and so belong to a second or later generation of the heavenly bodies?

During the short historic period, indeed, there is no record of such an event; still it would seem to be only through the collision of dark suns, of which the number must be increasing, that a temporary rejuvenescence of the heavens is possible, and by such ebbings and flowings of stellar life that the inevitable end to which evolution in its apparently uncompensated progress is carrying us can even for a little be delayed.

We cannot refuse to admit as possible such an origin for nebulæ.

In considering, however, the formation of the existing nebulæ we must bear in mind that in the part of the heavens within our ken the stars still in the early and middle stages of evolution exceed greatly in number those which appear to be in an advanced condition of condensation. Indeed, we find some stars which may be regarded as not far advanced beyond the nebular condition.

It may be that the cosmical bodies which are still nebulous owe their later development to some conditions of the part of space where they occur, such as conceivably a greater original homogeneity, in consequence of which condensation began less early. In other parts of space condensation may have been still further delayed, or even have not yet begun. It is worthy of remark that these nebulæ group themselves about the Milky Way, where we find a preponderance of the white-star type of stars, and almost exclusively the bright-line stars which Pickering associates with the planetary nebulæ. Further, Dr. Gill concludes, from the rapidity with which they impress themselves upon the plate, that the fainter stars of the Milky Way also, to a large extent, belong to this early type of stars. At the same time other types of stars occur also over this region, and the red hydrocarbon stars are found in certain parts; but possibly these stars may be before or behind the Milky Way, and not physically connected with it.

If light matter be suggested by the spectrum of these nebulæ, it may be asked further, as a pure speculation, whether in them we are witnessing possibly a later condensation of the light matter which had been left behind, at least in a relatively greater proportion, after the first growth of worlds into which the heavier matter condensed, though not without some entanglement of the lighter substances. The wide extent and great diffuseness of this bright line nebulosity over a large part of the constellation of Orion may be regarded, perhaps, as pointing in this direction. The diffuse nebulous matter streaming round the Pleiades may possibly be another instance, though the character of its spectrum has not yet been ascertained. In the planetary nebulæ, as a rule, there is a sensible increase of the faint continuous spectrum, as well as a slight thickening of the bright lines towards the centre of the nebula, appearances which are in favour of the view that these bodies are condensing gaseous masses.

Prof. G. Darwin, in his investigation of the equilibrium of a rotating mass of fluid, found, in accordance with the independent researches of Poincaré, that when a portion of the central body becomes detached through increasing angular velocity, the portion should bear a far larger ratio to the remainder than is observed in the planets and satellites of the solar system, even taking into account heterogeneity from the condensation of the parent mass.

(To be continued.)

ADDRESS TO THE MATHEMATICAL AND PHYSICAL SECTION OF THE BRITISH ASSOCIATION.

BY PROF. OLIVER J. LODGE, D.SC., PRESIDENT OF THE SECTION.

(Concluded from page 188.)

In the early days of the Copernican theory, Galileo for some years refrained from teaching it, though fully believing its truth, because he considered that he had better get more fully settled in his university chair before evoking the storm of controversy which the abandonment of the Ptolemaic system would arouse. The same thing in very minor degree is going on to-day. I know of men who hesitate to avow interest in these new investigations (I do not mean credence—the time is too early for avowing credence in any but the most rudimentary and definitely ascertained facts—but hesitate to avow interest) until they have settled down more securely and made a name for themselves in other lines. Caution and slow progress are extremely necessary; fear of avowing interest or of examining into unorthodox facts is, I venture to say, not in accordance with the highest traditions of the scientific attitude.

We are, I suppose, to some extent afraid of each other, but we are still more afraid of ourselves. We have great respect for the opinions of our elders and superiors; we find the matter distasteful to them, so we are silent. We have, moreover, a righteous mistrust of our own powers and knowledge; we perceive that it is a wide region extending into several already cultivated branches of science, that a many-sided and highly-trained mind is necessary adequately to cope with all its ramifications, that in the absence of strict enquiry imposture has been rampant in some portions of it for centuries, and that unless we are preternaturally careful we may get led into quagmires if we venture on it at all.

Now let me be more definite, and try to state what this field is, the exploration of which is regarded as so dangerous. I might call it the borderland of physics and psychology. I might call it the connection between life and energy; or the connection between mind and matter. It is an intermediate region, bounded on the north by psychology, on the south by physics, on the east by physiology, and on the west by pathology and medicine. An occasional psychologist has groped down into it and become a metaphysician. An occasional physicist has wandered up into it and lost his base, to the horror of his quondam brethren. Biologists mostly look at it askance, or deny its existence. A few medical practitioners, after long maintenance of a similar attitude, have begun to annex a portion of its western frontier. The whole region seems to be inhabited mainly by savages, many of them, so far as we can judge from a distance, given to gross superstition. It may, for all I know, have been hastily traversed and rudely surveyed by a few clear-eyed travellers; but their legends concerning it are not very credible, certainly are not believed.

Why not leave it to the metaphysicians? I say it has been left to them long enough. They have explored it with insufficient equipment. The physical knowledge of the great philosophers has been necessarily scanty. Men of genius they were, and their writings may, when interpreted, mean much. But to us, as physicists, they are unsatisfactory; their methods are not our methods. They may be said to have floated a balloon over the region with a looking-glass attached, in which they have caught queer and fragmentary glimpses. They may have seen more than we give them credit for, but they appear to have guessed far more than they saw.

Our method is different. We prefer to creep slowly from our base of physical knowledge, to engineer carefully as we go, establishing forts, making roads, and thoroughly exploring the country; making a progress very slow, but very lasting. The psychologists from their side may meet us. I hope they will; but one or other of us ought to begin.

A vulnerable spot on our side seems to be the connection between life and energy. The conservation of energy has been so long established as to have become a commonplace. The relation of life to energy is not understood. Life is not energy, and the death of an animal affects the amount of energy no whit; yet a live animal exerts control over energy which a dead one cannot. Life is a guiding or directing principle, disturbing to the physical world, but not yet given a place in the scheme of physics. The transfer of energy is accounted for by the performance of work; the guidance of energy needs no work, but demands force only. What is force? and how can living beings exert it in the way they do? As automata, worked by preceding conditions—that is, by the past—say the materialists? Are we so sure that they are not worked by the future, too? In other words, that the totality of things, by which everyone must admit that actions are guided, includes the future as well as the past, and that to attempt to deduce those actions from the past only will prove impossible.* In some way matter can be moved, guided, disturbed by the agency of living beings; in some way there is a control, a directing agency active, and events are caused as its choice and will that would otherwise not happen.

A luminous and helpful idea is that *time* is but a relative mode of regarding things; we progress through phenomena at a certain definite pace, and this subjective advance we interpret in an objective manner, as if events necessarily happened in this order and at this precise rate. But that may be only one mode of regarding them. The event may be in some sense existent always, both past and future, and it may be we who are arriving at them, not they which are happening. The analogy of a traveller in a railway train is useful. If he could never leave the train nor alter its pace, he would probably consider the landscapes as necessarily successive, and be unable to conceive their co-existence.

The analogy of a solid cut into sections is closer. We recognise the universe in sections, and each section we call the present. It is like the string of slices cut by a microtome; it is our way of studying the whole. But we may err in supposing that the body only exists in the slices which pass before our microscope in regular order and succession.

We perceive, therefore, a possible fourth dimensional aspect about time, the inexorableness of whose flow may be a natural part of our present limitations. And if once we grasp the idea that past and future may be actually existing, we can recognise that they may have a controlling influence on all present action, and the two together may constitute "the higher plane," or the totality of things, after which, as it seems to me, we are impelled to seek, in connection with the directing of force or determinism, and the action of living beings consciously directed to a definite and preconceived end.

Inanimate matter is controlled by the *vis à tergo*; it is operated on solely by the past.† Given certain conditions, and the effect in due time follows. Attempts have been made to apply the same principle to living and conscious beings, but without much success. These seem to work for an object, even if it be the mere seeking for food; they are controlled by the idea of something not yet palpable. Given certain conditions, and their action cannot certainly be predicted; they have a sense of option and free will. Either their actions are really arbitrary and indeterminate, which is highly improbable, or they are controlled by the future as well as by the past. Imagine beings thus controlled: automata you may still call them, but they will be living automata, and will exhibit all the characteristics of live creatures. Moreover, if they have a merely experiential knowledge, necessarily limited by memory and bounded by the past, they will be unable to predict each other's actions with any certainty, because the whole of the data are not before them. May not a clearer apprehension of the meaning of life, and will, and determinism be gradually reached in some such direction as this?

By what means is force exerted, and what, definitely, is force? I can hardly put the question here and now so as to be intelligible, except to those who have approached and thought over the same difficulties; but I venture to say that there is here something not provided for in the orthodox scheme of physics; that modern physics is not complete, and that a line of possible advance lies in this direction.

I might go further. Given that force can be exerted by an act of will, do we understand the mechanism by which this is done? And if there is a gap in our knowledge between the conscious idea of a motion and the liberation of muscular energy needed to accomplish it, how do we know that a body may not be moved without ordinary material contact by an act of will? I have no evidence that such a thing is possible. I have tried once or twice to observe its asserted occurrence, and failed to get anything that satisfied me. Others may have been more fortunate. In any case, I hold that we require more knowledge before we can deny the possibility. If the conservation of energy were upset by the process, we should have grounds for denying it; but nothing that we know is upset by the discovery of a novel medium of communication, perhaps some more immediate action through the ether. It is no use theorising; it is unwise to decline to examine phenomena because we feel too sure of their impossibility. We ought to know the universe very thoroughly and completely before we take up that attitude.

Again, it is familiar that a thought may be excited in the brain of another person, transferred thither from our brain, by pulling a suitable trigger; by liberating energy in the form of sound, for instance, or by the mechanical act of writing, or in other ways. A pre-arranged code called language, and a material medium of communication, are the recognised methods. May there not also be an immaterial (perhaps an ethereal) medium of communication? Is it possible that an idea can be transferred from one person to another by a process such as we have not yet grown accustomed to, and know practically nothing about? In this case I have evidence. I assert that I have seen it done, and am perfectly convinced of the fact. Many others are satisfied of the truth of it too. Why must we speak of it with bated breath, as of a thing of which we are ashamed? What right have we to be ashamed of a truth?

And after all, when we have grown accustomed to it, it will not seem altogether strange. It is, perhaps, a natural consequence of the community of life or family relationship running through all living beings. The transmission of life may be likened in some ways to the transmission of magnetism, and all magnets are sympathetically connected, so that if suitably suspended a vibration from one disturbs others, even though they be distant ninety-two million miles.

It is sometimes objected that, granting thought-transference or telepathy to be a fact, it belongs more especially to lower forms of life and that as the cerebral hemispheres develop we become independent of it; that what we notice is the relic of a decaying faculty, not the germ of a new and fruitful sense; and that progress is not to be made by studying or attending to it. It may be that it is an immature mode of communication, adapted to lower stages of consciousness than ours, but how much can we not learn by studying immature stages? As well might the objection be urged against a study of embryology. It may, on the other hand, be an indication of a higher mode of communication, which shall survive our temporary connection with ordinary matter.

I have spoken of the apparently direct action of mind on mind, and of a possible action of mind on matter. But the whole region is unexplored territory, and it is conceivable that matter may react on mind in a way we can at present only dimly imagine. In fact, the barrier between the two may gradually melt away, as so many other barriers have done, and we may end in a wider perception of the unity of Nature, such as philosophers have already dreamt of.

I care not what the end may be. I do care that the enquiry shall be conducted by us, and that we shall be free from the disgrace of jogging along accustomed roads, leaving to outsiders the work, the ridicule, and the gratification of unfolding a new region to unwilling eyes.

It may be held that such investigations are not physical, and do not concern us. We cannot tell without trying. In that I trust my instinct. I believe there is something in this region which does concern us as physicists. It may concern other sciences too. It must, one would suppose, some day concern biology; but with that I have nothing to do. Biologists have their region, we have ours, and there is no need for us to hang back from an investigation because they do. Our own science, of physics or natural philosophy in its widest sense, is the king of the sciences, and it is for us to lead, not to follow.

And I say, have faith in the intelligibility of the universe. Intelligibility has been the great creed in the strength of which all intellectual advance has been attempted, and all scientific progress made.

At first things always look mysterious. A comet, lightning, the aurora, the rainbow—all strange anomalous mysterious apparitions. But scrutinised in the dry light of science, their relationship with other better known things becomes apparent. They cease to be anomalous; and though a certain mystery necessarily remains, it is no more a property peculiar to them: it is shared by the commonest objects of daily life.

The operations of a chemist, again, if conducted in a haphazard manner, would be an indescribable medley of effervescences, precipitations, changes in colour and in substance; but, guided by a thread of theory running through them, the processes fall into a series, they all become fairly intelligible, and any explosion or catastrophe that may occur is capable of explanation too.

Now I say that the doctrine of ultimate intelligibility should be pressed into other departments also. At present we hang back from whole regions of enquiry and say they are not for us. A few we are beginning to grapple with. The nature of disease is yielding to scrutiny with fruitful result; the mental aberrations and abnormalties of hypnotism, duplex personality, and allied phenomena, are now at last being taken under the wing of science after long ridicule and contempt. The phenomenon of crime, the scientific meaning and justification of altruism, and other matters relating to life and conduct, are beginning, or perhaps are barely yet beginning, to show a vulnerable front over which the forces of science may pour.

Facts so strange that they have often been called miraculous are now no longer regarded as entirely incredible. All occurrences seem reasonable when contemplated from the right point of view, and some are believed in which in their essence are still quite marvellous. Apply warmth for a given period to a sparrow's egg, and what result could be more incredible or magical if now discovered for the first time? The possibilities of the universe are as infinite as is its physical extent. Why should we grope with our eyes always downward, and deny the possibility of everything out of our accustomed beat?

If there is a puzzle about free will, let it be attacked; puzzles mean a state of half knowledge. By the time we can grasp something more approximating to the totality of things the paradoxity of paradoxes drops away and becomes unrecognisable. I seem to myself to catch glimpses of clues to many of these old questions, and I urge that we should trust consciousness, which has led us thus far; should shrink from no problem when the time seems ripe for an attack upon it, and should not hesitate to press investigation, and ascertain the laws of even the most recondite problems of life and mind.

What we know is as nothing to that which remains to be known. This is sometimes said as a truism; sometimes it is half doubted. To me it seems the most literal truth, and that if we narrow our view to already half-conquered territory only, we shall be false to the men who won our freedom, and treasonable to the highest claims of science.

I must now return to the work of this section, from which I have apparently wandered rather far afield, further than is customary—perhaps further than is desirable. But I hold that occasionally a wide outlook is wholesome, and that without such occasional survey the rigid attention to detail and minute scrutiny of every little fact which are so entirely admirable and are so rightly here fostered, are apt to become unhealthily dull and monotonous. Our life-work is concerned with the rigid framework of facts, the skeleton or outline map of the universe; and, though it is well for us occasionally to remember that the texture and colour and beauty which we habitually ignore are not therefore in the slightest degree non-existent, yet it is safest speedily to return to our base and continue the slow and laborious march with which we are familiar and which experience has justified. It is because I imagine that such systematic advance is now beginning to be possible in a fresh and unexpected direction that I have attempted to direct your attention to a subject which, if my prognostications are correct, may turn out to be one of special and peculiar interest to humanity.

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* The expression "controlled by the future," I first heard in a conversation with G. F. Fitzgerald, who seemed to consider it applicable to all events, without exception.

† This is, of course, not assertion but suggestion. It may be erroneous to draw any such distinction between animate and inanimate.

THE LONDON-PARIS TELEPHONE.*

BY W. H. PREECE, F.R.S.

1. I have already on two occasions, at Newcastle and at Leeds, brought this subject before Section G, and have given the details of the length and construction of the proposed circuit. I have now to report not only that the line has been constructed and opened to the public, but that its success, telephonic and commercial, has exceeded the most sanguine anticipations. Speech has been maintained with perfect clearness and accuracy. The line has proved to be much better than it ought to have been, and the purpose of this paper is to show the reason why.

The lengths of the different sections of the circuit are as follows:

London to St. Margaret's Bay	84·5	miles.
St. Margaret's Bay to Sangatte (cable)	23·	,,
Sangatte to Paris	199·	,,
Paris underground	4·8	,,
Total	311·3	,,

The resistances are as follows:

Paris underground	70	ohms.
French line	294	,,
Cable	143	,,
English line	183	,,
Total (R)	693	,,

The capacities are as follows:

Paris underground	0·43	microfarads.
French line	3·33	,,
Cable	5·52	,,
English line	1·32	,,
Total (K)	10·62	,,

$$693 \times 10{\cdot}62 = 7{,}359 = K\,R,$$

a product which indicates that speech should be very good.

2. *Trials of Apparatus.*—The preliminary trials were made during the month of March between the chief telegraph offices of the two capitals, and the following microphone transmitters were compared:

Ader	Pencil form.
Berliner	Granular ,,
D'Arsonval	Pencil ,,
De Jongh	,, ,,
Gower-Bell	,, ,,
Post Office switch instrument	Granules and lamp filaments.
Roulez	Lamp filaments.
Turnbull	Pencil form.
Western Electric	Granular.

The receivers consisted of the latest form of double-pole Bell telephones with some Ader and D'Arsonval receivers for comparison. After repeated trials it was finally decided that the Ader, D'Arsonval, Gower-Bell (with double-pole receivers instead of tubes), Roulez, and Western Electric were the best, and were approximately equal.

These instruments were, therefore, selected for the further experiments, which consisted of using local extensions in Paris and London. The wires were in the first instance extended at the Paris end to the Observatory through an exchange at the Avenue des Gobelines. The length of this local line is 7 kms. The wires are guttapercha covered, placed underground, and not suitable for giving the best results.

The results were, however, fairly satisfactory. The wires were extended to the Treasury in London by means of the ordinary underground system. The distance is about two miles, and although the volume of sound and clearness of articulation were perceptibly reduced by these additions to the circuit, conversation was quite practicable.

Further trials were also made from the Avenue des Gobelines on underground wires of five kilometres long, and also with some renters in Paris with fairly satisfactory results. The selected telephones were equally efficient in all cases, which proves that to maintain easy conversation when the trunk wires are extended to local points it is only necessary that the local lines shall be of a standard not lower than that of the trunk line. The experiments also confirm the conclusion that long-distance speaking is solely a question of the circuit and its environments, and not one of apparatus. The instruments finally selected for actual work were Gower-Bell for London and Roulez for Paris.

3. The results are certainly most satisfactory. There is no circuit in or out of London on which speech is more perfect than it is between London and Paris. In fact, it is better than I anticipated, and better than calculation led me to expect. Speech has been possible not only to Paris but through Paris to Bruxelles, and even, with difficulty, through Paris to Marseilles, a distance of over 900 miles. The wires between Paris and Marseilles are massive copper wires specially erected for telephone business between those important places.

4. *Business Done.*—The charge for a conversation between London and Paris is 8s. for three minutes' complete use of the wire. The demand for the wire is very considerable. The average number of talks per day, exclusive of Sunday, is 86. The maximum has been 108. We have had as many calls as 19 per hour—the average is 15 during the busy hours of the day. As an instance of what can be done 150 words per minute have been dictated in Paris and transcribed in London by shorthand writing. Thus in three minutes 450 words were recorded, which at 8s. cost five words for a penny.

5. *Difficulties.* — The difficulties met with in long-distance speaking are several, and they may be divided into (*a*) those due to external disturbances and (*b*) those due to internal opposition.

(*a*.) Every current rising and falling in the neighbourhood of a telephone line within a region, say, of 100 yards, whether the wire conveying it be underground or overground, induces in the telephone circuit another current, producing in the telephone a sound which disturbs speech, and if the neighbouring wires are numerous and busy, as they are on our roads and railways, these sounds become confusing, noisy, and ultimately entirely preventative of speech. This disturbance is, however, completely removed by forming the telephone circuit of two wires placed as near to each other as possible, and twisted around each other without touching, so as to maintain the mean average distance of each wire from surrounding conductors the same everywhere. Thus similar currents are induced in each of the two wires, but being opposite in direction, as far as the circuit is concerned, they neutralise each other, and the circuit, therefore, becomes quite silent.

In England we make the two wires revolve completely round each other in every four poles, but in France it is done in every six poles. The reason for the change is the fact that in the English plan the actual crossing of the wires takes place in the span between the poles, while in the French plan it takes place at the poles. This is supposed to reduce the liability of the wires to be thrown into contact with each other by the wind, but, on the other hand, it diminishes the geometrical symmetry of the wires—so very essential to ensure silence. As a matter of fact, contacts do not occur on well-constructed lines, and I think our English wires, being more symmetrical, are freer from external disturbance than those in France.

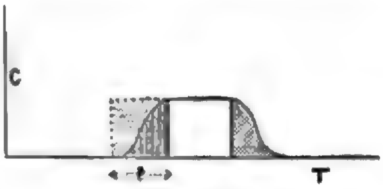

FIG. 1.

(*b*.) The internal opposition arises from the resistance, R, the capacity, K, and the electromagnetic inertia, L, of the circuit. A current of electricity takes time to rise to its maximum strength and time to fall back again to zero. Every circuit has what is called its time constant, *t*, Fig. 1, which regulates the number of current waves which can be transmitted through it per second. This is the time the current takes to rise from zero to its working maximum and the time it takes to fall from this maximum to zero again, shown by the shaded portions of the figure; the duration of the working current being immaterial and shown by the unshaded portion. The most rapid form of quick telegraphy requires about 150 currents per second, currents each of which must rise and fall in $\frac{1}{150}$th of a second, but for ordinary telephone speaking we must have about 1,500 currents per second, or the time which each current rises from zero to its maximum intensity must not exceed $\frac{1}{3000}$th part of a second. The time constant of a telephone circuit should therefore not be less than ·0003 second.

Resistance alone does not affect the time constant. It diminishes the intensity or strength of the currents only; but resistance, combined with electromagnetic inertia and with capacity, has a serious retarding effect on the rate of rise and fall of the currents. They increase the time constant and introduce a slowness which may be called retardance, for they diminish the rate at which currents can be transmitted. Now the retardance due to electromagnetic inertia increases directly with the amount of electromagnetic inertia present, but it diminishes with the amount of resistance of the conductor. It is expressed by the ratio $\frac{L}{R}$ while that due to capacity increases directly, both with the capacity and with the resistance, and it is expressed by the product, K R. The whole retardance, and, therefore, the speed of working the circuit or the clearness of speech, is given by the equation

$$\frac{L}{R} + K\,R = t$$

or

$$L + K\,R^2 = R\,t.$$

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* Paper read before the British Association.

ow in telegraphy we are not able altogether to eliminate L, but we can counteract it, and if we can make $R\,t = 0$, then

$$L = -K R^2,$$

which is the principle of the shunted condenser that has been introduced with such signal success in our Post Office service, and has virtually doubled the carrying capacity of our wires.

If, in the above equation, we make $L = 0$

$$K R = t.$$

This is done in telephony, and hence we obtain the law of retardance, or the law by which we can calculate the distance to which speech is possible. All my calculations for the London and Paris line were based on this law, which experience has shown it to be true.

How is electromagnetic inertia practically eliminated? First, by the use of two massive copper wires, and secondly by symmetrically revolving them around each other. Now L depends on the geometry of the circuit, that is, on the relative form and position of the different parts of the circuit, which is invariable for the same circuit, and is represent by a coefficient, λ. It depends also on the magnetic qualities of the conductors employed and of the space embraced by the circuit. This specific magnetic capacity is a variable quantity, and is indicated by μ for the conductor and by μ_0 for air. It depends also on the rate at which currents rise and fall, and this is indicated by the differential coefficient $\frac{dC}{dt}$. It depends finally on the number of lines of force due to its own current which cut the conductor in the proper direction; this is indicated by β. Combining these together we can represent the electromagnetic inertia of a metallic telephone circuit as

$$L = \lambda(\mu + \mu_0)\frac{dC}{dt} \times \beta.$$

Now, $\lambda = 2 \log \frac{d^2}{a^2}$. Hence the smaller we make the distance, d, between the wires, and the greater we make their diameter, a, the smaller becomes λ. It is customary to call the value of μ for air, and copper, 1, but this is purely artificial and certainly not true. It must be very much less than one in every medium, excepting the magnetic metals, so much so that in copper it may be neglected altogether while in the air it does not matter what it is, for by the method of twisting one conductor round the other, the magnetisation of the air space by the one current of the circuit rotating in one direction is exactly neutralised by that of the other element of the circuit rotating in the opposite direction. Now, β, in two parallel conductors conveying currents of the same sense, that is flowing in the same direction, is retarding, Fig. 2, and is therefore a positive quantity, but when the currents flow in opposite directions, as in a metallic loop, Fig. 3, they tend to assist each other and are of a negative character. Hence in a metallic telephone circuit we may neglect L *in toto* as I have done.

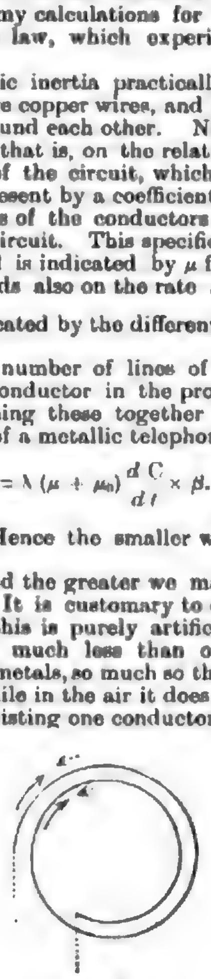

FIG. 2.

I have never yet succeeded in tracing any evidence of electromagnetic inertia in long single copper wires, while in iron wires the value of L may certainly be taken at ·005 henry per mile.

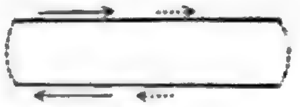

FIG. 3.

In short metallic circuits, say of lengths up to 100 miles, this negative quantity does not appear, but in the Paris-London circuit this helpful mutual action of opposite currents comes on in a peculiar way. The presence of the cable introduces a large capacity practically in the centre of the circuit. The result is that we have in each branch of the circuit between the transmitter, say, at London and the cable at Dover, extra currents at the commencement of the operation, which, flowing in opposite directions, mutually react on each other, and practically prepare the way for the working currents. The presence of these currents is proved by the fact that when the cable is disconnected at Calais, as shown in Fig. 5, and telephones are inserted in series, as shown at D and D′, speech is as perfect between London and St. Margaret's Bay as if the wires were connected across, or as if the circuit were through to Paris. Their effect is precisely the same as though the capacity of the aerial section were reduced by a quantity, M, which is of the same dimension or character as K. Hence, our retardance equation becomes

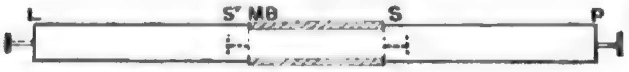

FIG. 4.

$$R(K - M) = t.$$

Thus it happens that the London-Paris telephone works better than was expected. The nature of M is probably equivalent to about ·0075 ϕ per mile, and therefore K should be also about ·0075 ϕ instead of ·0156 ϕ per mile. This helpful action of mutual induction is present in all long circuits, and it is the reason why we were able to speak to Brussels and even to Marseilles. It also appears in every metallic loop, and vitiates the measurements of electromagnetic inertia and of capacity of loops. Thus, if we measure the capacity of a loop as compared with a single wire, the amount per mile may be 50 per cent. greater than it ought to be; while if we measure the capacity of one branch of a circuit under the conditions of the London-Paris telephone line, it may be 50 per cent. less than it ought to be. This effect of M is shown by the dotted line in Fig. 1.

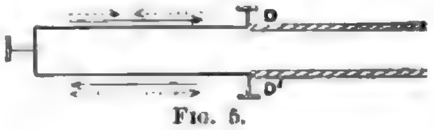

FIG. 5.

Telephonic currents—that is, currents induced in the secondary wire of an induction coil due to the variation of microphonic currents in the primary wire—are not alternating currents. They do not follow the constant periodic law, and they are not true harmonic sine functions of the time. The microphonic currents are intermittent or pulsatory, and always flow in the same direction. The secondary currents are also always of the same sign, as are the currents in a Ruhmkorff coil, and as are the currents in high vacua with which Crookes has made us so familiar. Moreover, the frequency of these currents is a very variable quantity, not only due to the various tones of voices, but to the various styles of articulation. Hence the laws of periodic alternate currents following the sine function of the time fail when we come to consider microphones and telephones. It is important to bear this in mind, for nearly everything that has hitherto been written on the subject assumes that telegraphic currents follow this periodic sine law. The currents derived from Bell's original magneto-transmitters are alternate, and comply more nearly with the law. The difference between them and microphones is at once perceptible. Muffling and disturbance due to the presence of electromagnetic inertia become evident, which are absent with microphones. I tested this between London and St. Margaret's, and found the effect most marked.

7. *Lightning.*—A metallic telephone circuit may have a static charge induced upon it by a thunder cloud, as shown in Fig. 6. Such a charge is an electric strain which is released when the charged cloud flashes into the earth or into a neighbouring cloud. If there be electromagnetic inertia present, the charge will surge backward and forward through the circuit until it dies out. If there be no E.M.F. present it will cease suddenly, and neutrality will be attained at once. Telephone circuits indicate this operation by peculiar and characteristic sounds. An iron wire circuit produces a long swish or loud sigh, but a copper wire circuit like the Paris-London telephone emits a short, sharp report, like the crack of a pistol, which is sometimes startling, and has created fear, but there is no danger or liability to shock. Indeed, the start has more than once thrown the listener off his stool, and has led to the belief that he was knocked down by lightning.

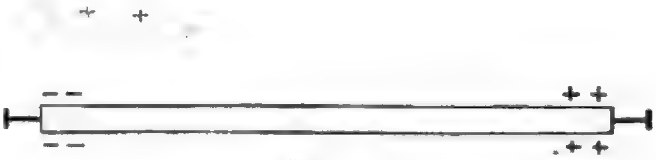

FIG. 6.

8. The future of telephone working, especially in large cities, is one of underground wires, and the way to get over the difficulties of this kind of work is perfectly clear. We must have metallic circuits, twisted wires, low resistance, and low capacity. In Paris a remarkable cable, made by Fortin-Herman, gives an exceedingly low capacity—viz., only ·069 ϕ per mile. In the United States they are using a wire insulated with paper which gives ·08 ϕ per mile. We are using in London Fowler-Waring cable giving a capacity of 1·8 ϕ per mile, the capacity of gutta-covered wire being 3 ϕ per mile.

THE MEASUREMENT OF LIQUID RESISTANCES.*

BY J. SWINBURNE.

The great difficulties in measuring liquid resistances arise from polarisation at the electrodes. Various methods of eliminating the errors arising from polarisation, and from variations of surface resistance due to bubbles, have come into use; the most usual being to employ an alternating current and a telephone.

The following are some methods of avoiding polarisation errors in a manner analogous to that employed by Sir William Thomson, Mr. Heaviside, and others, in measuring low resistances. In measuring low resistances, the resistances of the contacts are high in comparison, and have to be eliminated. Fig. 1 shows the vessel employed. It consists of a glass tube, with cups, A and B, at the ends, for the main electrodes. Near the ends are feeler cups, C D, and it is the difference of potential of these feeler cups that is measured. They are connected by means of parchmented syphon tubes, such as those used in Raoult's cell, with vessels containing electrodes in a suitable electrolyte. For instance, suppose the resistance of sulphuric acid is to be measured. The main electrodes are platinum or lead. The syphon tubes are filled with acid and connected to vessels filled with sulphate of zinc. The electrodes in these are zinc amalgam. The apparatus may be arranged either so that there is no current from *c* to *d*, or so that there is a current which may polarise the amalgams a little. In this case the polarisation can be observed. Fig. 2 shows a method with no current. The main circuit from the battery E is through a resistance R, which is fairly large, so that variations of resistance or back-pressure elsewhere in the circuit do not affect the current much. Then it passes through a standard resistance, S, to the main electrode, then through the tube back to the battery. The fall of pressure between the feelers, *c* and *d*, is compared with that over the standard resistance, S, by means of the potentiometer arrangement shown diagrammatically. For accurate work a resistance-box is used; the wire is only shown for clearness. In this case there is no current in the feeler circuit, and, therefore, no polarisation. A deflection can be taken on each side of zero if desired, so as actually to reverse the current. Polarisation of the feeler electrodes can also be detected instantly by breaking both the cell circuits. There should then be no deflection. The drawback to this method is that successive readings have to be taken, and if bubbles are coming off the main electrodes the main current can never be quite constant. Fig. 3 shows another disposition with a differential galvanometer, whose coils are lettered G H. In this case there is a current in the feeler circuit. To make sure that it produces no error, the direction of the main current is commuted quickly at K. Any polarisation then gives a double deflection. The apparatus may also be coupled up as a Thomson low-resistance bridge. By varying the number of cells Ohm's law can be checked.

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* Paper read before the British Assocition.

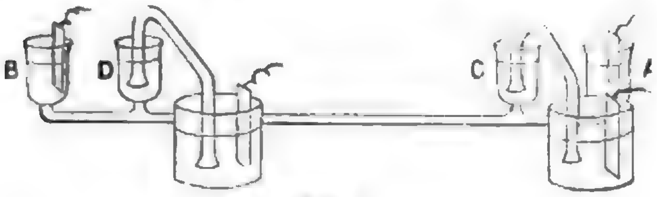

Fig. 1.

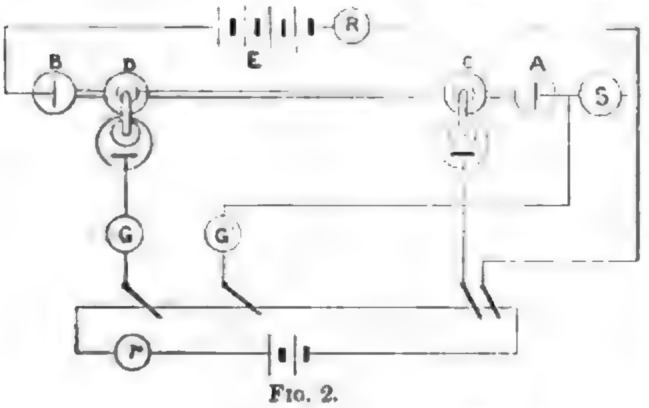

Fig. 2.

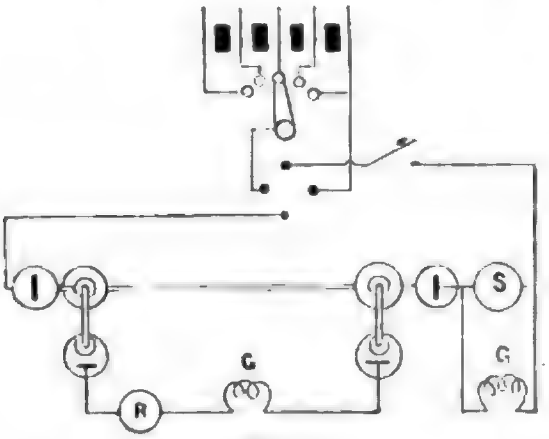

Fig. 3.

Amalgamated zinc does polarise slightly, or some other action takes place which produces an equivalent result. Unless the time of contact is long, however, it does not give rise to trouble. Polarisation shows at once by the deflection on lifting the main key.

The main tube is calibrated by filling it with mercury. Mine is straight, but it would be better to coil it up to go into a water bath easily. If one syphon tube is not enough a second intermediate tube with a vessel can be used. I think one is generally enough, however. For instance, for measuring caustic sulphate of soda would be used in the syphon tubes, and so on. I have not experimented on electrodes yet. Amalgams of silver or copper in suitable solutions, or mercury in mercurous nitrate, may be better.

THE CAUSES OF VARIATION OF CLARK STANDARD CELLS.*

BY J. SWINBURNE.

It is well known to those who have worked with them that Clark standard cells are not yet to be trusted in very accurate work. It is quite easy to make up a few cells which agree among themselves, but they seldom agree with others made up at different times with different chemicals by different people, and they often take long to "settle down." No one who wanted a standard within less than one-tenth per cent. would set up a Clark and trust it without comparing it with other cells. The measurement of E.M.F.'s can easily be made within not only one in a thousand, but one in a million, and as we already have accurate resistances, a standard cell giving even approximately accurate results would be of enormous value.

It, therefore, seemed worth while to investigate the causes of variation of Clark cells. Such an examination must necessarily be laborious, and it took up a great deal more time even than I expected. I must also pass over a great deal in order to confine my paper within the limits usual at the British Association.

The Clark cell has already received the most careful attention from Mr. Latimer Clark and Dr. A. Muirhead, who has, I believe, already gone thoroughly into the chemistry of it, and from Messrs. Wright and Thomson. Lord Rayleigh has, perhaps, gone into the matter more carefully than anyone else, and Messrs. Carhart, Dearlove, Skinner, Fleming, Crompton, and very many others have worked at the same subject.

The method I have followed is to take the various parts of the cell separately, beginning at the zinc and eliminating the rest of the cell.

The cell taken as standard throughout most of this investigation was made in strict accordance with the latest Board of Trade Committee's circular. Two were made at the same time, and one (No. 1,614) was sent to the committee, while the other (No. 1,615) was kept for reference. They agreed nearly enough to give no deflection when coupled back to back through a 100-ohm reflecting galvanometer. I have not yet heard how this cell agreed with the committee's standards.

My arrangement for measuring E.M.F.'s would read about 0·000002 of a volt, but it was useless taking such accurate readings generally, as the last few places of decimals were nearly always swamped by errors due to variations of temperature coefficients. The accuracy of reading is erroneously greater than that of the cells to be read. In many cases, however, the internal resistances of the cells were very great, and readings could be taken within a few places of decimals only.

Cell No. 1,615, or as I may call it for reference, the B.O.T. cell, was always kept in the water bath, in which all cells under examination were left. All the apparatus was insulated by being fastened to the celluloid plaques fastened to the wall, or by standing on celluloid mats. I had no leakage.

VARIATIONS DUE TO ZINC.

The following zincs were tried: 1,620 and 1,625 from Townson and Mercer, labelled "free from arsenic;' 1,621 "pure," from Hopkin and Williams; 1,622, Becker's second quality; 1,623, roofing zinc. These were first filed and sand-papered, washed in caustic soda, dried with filter paper, washed with dilute sulphuric acid, and then with distilled water. This is the orthodox way of preparing zincs. It is much quicker to dip them in strong nitric acid, which gives a surface like silver at once if the zinc has not been amalgamated. These zincs were suspended in a carbonic acid flask in a saturated solution of zinc sulphate which had been shaken up with barium carbonate and filtered. I need not give the tables of readings of these zincs. At first they varied about 0·4 per cent.—that is to say, they would have caused variations of 0·4 per cent. of the E.M.F. of a complete cell. The variation increased to more than half per cent. I did not take readings of over a half per cent. Sometimes one zinc was higher, sometimes another, and on shaking the flask a little the readings were altered. This behaviour was partly due to impurities, probably iron, in the zinc sulphate. On shaking a new clean surface of zinc was wetted and exposed. A black high-water mark appeared on the zincs after some time.

The zincs were cleaned again and dipped for a moment in a weak solution of acid mercuric sulphate and washed. They were thus very slightly amalgamated. They were tested in solution 1,628, nearly free from iron; 1,622 and 1,625 then read 1·00005, while 1,620, 1,623 agreed with 1,621, which was taken as standard. These measurements can be taken with great accuracy, as the resistances in circuit are low; 1,620 and 1,625 were pieces of the same rod of zinc. After an hour the zincs came within about four in a million. One of them, 1,625, was then thickly amalgamated by dipping in acid mercuric sulphate. Drops of mercury hung to it. It read 0·999910, 0·999976, 0·999988, and finally one in the course of two minutes. The zincs were then put back into solution 1,624, which gave so much trouble before. They now read within one or two in a million. After standing for nearly three weeks they were marked all over, and varied nearly a tenth per cent. among themselves, and more than that compared with 1,621, which had been in another solution acting as a standard in other experiments.

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* Paper read before the British Association.

From this it appears that in order to give good results the zincs should be heavily amalgamated. If thoroughly amalgamated, practically any zinc will do. The zincs which gave low E.M.F.'s were always the small ones—that is to say, those which would get the thickest coatings of iron.

To find out whether amalgamating altered the readings, an amalgam was made by touching mercury with zinc. It was more than ½ per cent. wrong. After dissolving more zinc, the reading was still low, though by stirring in zinc it soon came up to 0·9984 and 0·9994. A series of amalgams was made containing 25, 12½, 5, 2½, and 1 per cent. of zinc and one with less zinc. These were put in solution 1,628 of zinc sulphate with little iron. The solution was poured in and out many times to secure homogeneity, an important matter, to which I will return. The readings obtained were—

25 per cent.	1·000025	and	0·99999
12½ ,,	1·00008	,,	1·000000
5 ,,	1·000035	,,	1·000010
2½ ,,	1·00005	,,	1·000020
1 ,,	0·997225		
trace below	0·995		

The second readings, which were taken a few minutes later, are close enough. Amalgams therefore having some 2½ per cent. of zinc will do. Lord Rayleigh has done a great deal of work on amalgam cells, and he found the amalgam always cracked the tube. I made one H cell with amalgam in 1888 which had the platinum led out at the bottom, but it did not crack. I made several other cells at the same time with an internal test tube to hold the amalgam, and none of them cracked. On the other hand, the 5 per cent. amalgam broke its test tube. I would suggest that platinum sealed to German glass is always left under constraint, and the crystallisation of the zinc also adds pressure which cracks the tube. My H cell had a little lead glass just round the platinum; moreover, it was very small. The 2½ per cent. amalgam is liquid, so there is no danger from it.

To sum up as to the zinc, then, I would suggest that if rod be used it should be well amalgamated first. It is gradually amalgamated in the cell, but this process is slow, especially if the solution contains basic zinc sulphate. The gradual amalgamation is probably one process that makes many cells take a few weeks to arrive at final values. If zinc rod is used, it would seem better to use platinum, silver, or zinc wire to make connection, and to avoid solder, otherwise it is only a matter of time till the zinc falls off. All these troubles are swept away by the use of zinc amalgam, as proposed by Lord Rayleigh. There is another reason in its favour to be mentioned under the head of temperature coefficients.

THE ZINC SULPHATE SOLUTION.

The chief difficulty arises from the presence of iron. Samples were bought from Messrs. Hopkin and Williams and Becker. These both contained iron. Iron is often to be seen as a deposit after shaking up with zinc carbonate. Some sulphate of zinc was made by dissolving "pure" zinc in redistilled sulphuric acid. Provided there is always excess of zinc, one would expect little iron. Another batch was made by leaving excess of commercial granulated zinc in dilute commercial acid, which itself contains iron. Neither of these had enough iron to blacken zinc. None of the samples of zinc sulphate blackened copper. When I say that samples of sulphate of zinc bought as pure from such people as Messrs. Hopkin and Williams contain iron, I mean that they contain enough to cause variations in cells, not enough to get precipitates of Prussian blue. Zinc or barium carbonate might be expected to precipitate all the iron. It does not, however. Probably carbonate of iron really exists and remains in solution. In experiments on alkaline secondary cells with iron plates, I produced a green compound which appeared to be a real carbonate of iron. The best method of dealing with iron is to acknowledge its presence and amalgamate the zincs. The best zinc sulphate solutions I used were obtained by dissolving granulated zinc in dilute commercial acid, keeping the zinc in excess. Solution 1,628, already mentioned, was made this way. Of course, pure zinc and acid may be used. This method produces basic sulphate, too, especially if hot. This can be afterwards neutralised by acid.

It is usual to shake up zinc sulphate with "carbonate," and to filter before use. This is probably because the sulphate reddens litmus paper. Neutral zinc sulphate reddens litmus paper, however, so there seems little reason for adding zinc "carbonate." I imagine that any salt which can give up a little acid by forming a basic salt, will redden litmus. The sulphate can be neutralised by being left in contact with zinc. A solution that is strongly alkaline to methyl orange reddens litmus paper. What is bought as zinc "carbonate," is either a basic carbonate or a mixture containing oxide. There are some half-dozen basic sulphates of zinc, and shaking up with "carbonate" forms some of these. The presence of basic sulphate in the solution prevents the mercury salt getting to the zinc to amalgamate it. Mercurous sulphate is, I believe, split up by water into basic and acid mercurous sulphate. Basic zinc sulphate precipitates any normal mercurous sulphate that may be dissolved, and the acid sulphate as basic mercurous sulphate or as mercurous oxide. This accounts for the dark grey deposit often seen on the top of the paste in cells prepared in the usual way. The mercury salt thus cannot get to the zinc till the whole of the basic zinc salt has been used up.

In order to test the effects of various solutions of zinc sulphate, test tubes with feet were filled with the solutions, and were connected with the standard solution by a syphon tube. This had one end blocked with filter paper to prevent mixture of solutions. It is needless to give tables of readings. Anomalous results were obtained at first, but they were all traceable to the zincs. After amalgamation, all the saturated solutions gave the same readings within a few in a million. 1,621, made by dissolving pure zinc in acid, was 100 in a million too low.

To test the effect of acid, I added a few drops of "normal"—that is, very dilute sulphuric acid—to a saturated solution of Hopkin and Williams's zinc sulphate. The solution was then strongly acid to methyl orange. The solution read 1·001200 against zinc, 1,621 in some more of the same solution. On neutralising with zinc carbonate, the reading was 1·001100. Free acid appears to make little difference. This experiment was repeated with new solutions. The two zincs were first tested in the same solution. One gave about eight in a million; this was moved into the other tube, B, of the same solution and taken as a standard. The reading was now 1·000110 for A. Five drops of pure acid were put in a small test tube, and a little of A added, and the tube cooled. Then the acid was added to A, which became strongly acid to methyl orange. The reading was now 1·000000. The liquid was then shaken up with zinc carbonate till alkaline to orange, and the reading rose to 1·0009. On the other hand, a solution which had been left in contact with excess of zinc carbonate for some weeks gave no deflection. In any case, the zinc will eventually use up any free acid. These anomalous results may be partly due to slight differences of density in the solutions, and partly to unascertained causes.

This is the last point that need be mentioned in connection with the solution. The solubility of zinc sulphate varies enormously with the temperature. If a tube of it is left with crystals at the bottom, when it comes to a low temperature all the crystals collect at the foot. When the temperature rises, the upper part can only become saturated again slowly by diffusion. To test this, two zincs were put in a test tube of saturated solution with crystals at the bottom. After a few days the top zinc gave 1·0005 compared with the bottom. The lower zinc was then raised, reading 1. The other zinc was then depressed, reading 0·999475. The difference of density thus causes an error of 5 in 10,000. This tube was some 10 centimetres long, so the error in standard cells may not be so great as this, still, diffusion is very slow even in a short cell. This also influences the temperature coefficient. The question of supersaturation has already been dealt with so thoroughly by Lord Rayleigh that I saw no use in experimenting on it. There are some half-dozen hydrates and an anhydrous sulphate of zinc. If the solution is not heated above blood heat, the Zn SO_4 $7H_2O$ crystallises out.

To sum up: the chief errors caused by the solution are due to traces of iron and variations of density. The zinc should therefore be amalgamated. I would suggest that zinc carbonate be omitted. To avoid changes of density, if a saturated solution is imperative, a zinc amalgam must be employed with crystals lying on its surface. This can be done in one of Lord Rayleigh's H cells, or a smaller tube can be slipped into the cell. The surfaces must be on the same level, else all the crystals will collect on the lower one, as that lowers the centre of gravity of the system, thus doing work. A small test tube full of crystals was put inside a larger tube of saturated solution, and this action was found actually to take place.

There is some further complication between the zinc and its solution. Even amalgams will give very large variations if moved about in the solution. This is the case even with dilute solutions. I can scarcely hazard a suggestion. Some Lippmann effect may be produced by shaking the amalgam. This does not seem at all likely. It is possible that zinc, even when amalgamated, will dissolve in sulphate, forming basic sulphate, provided the zinc is moved so that the hydrogen can get away in solution, as it cannot come off in bubbles. Ordinary zinc will dissolve in boiling zinc sulphate solution, the solution turning milky on cooling; but I cannot make out whether amalgamated zinc does or not. In the cold it gives off bubbles slowly. I do not know whether any surface boundary layers can cause such effects; whether there is an action like a frictional electric machine going on.

MERCUROUS SULPHATE.

Samples of mercurous sulphate were bought from Messrs. Becker and Hopkin and Williams. I also had some samples from Hopkin and Williams, Becker and Griffin, bought in 1888, and some I made myself at the same time. I also prepared some new specimens by heating in an oven a flask with mercury twice distilled in vacuo and redistilled acid. The temperature was kept at 125deg. C. by a mercury regulator, and only a portion of the mercury was dissolved. The sulphate was washed with distilled water and dried. It is in white crystals.

Other samples were made by dissolving mercurous nitrate in water slightly acidified with nitric acid, and precipitating with zinc sulphate. This is perfectly white unless much washed. A yellow colour then appears.

There are several sulphates of mercury. There is mercuric sulphate, which, on shaking up with water, splits into acid mercuric sulphate, which is soluble, and basic mercuric sulphate, which is a bright yellow insoluble powder. There is, I believe, a mercuric-mercurous sulphalte. I do not know it, nor do I know if there are acid and basic salts to correspond. There is also mercurous sulphate, which some say is soluble in water, but which, I believe, splits up into acid mercurous sulphate, which is slightly soluble, and basic mercurous sulphate, which is a dirty yellow powder. In testing the pastes, some of that used for the

B.O.T. cells was used as a standard. Zinc No. 1,621 was kept in a solution of sulphate, and was connected by a syphon with the tube of standard paste, the cell thus made being checked against the B.O.T. standard. After a few days there was never any deflection. The pastes could not be measured so easily as zincs or solutions on account of their high resistance. There is also frequent trouble from want of contact with the platinum wires. Merely heating these and dipping in mercury is not always enough. I found it better to bend the platinum into an eye and to boil it in mercury, and not to consider it amalgamated till it took up a film of mercury with it, or to use sodium amalgam. The syphon tube was no longer stopped with filter paper, so its resistance was lower. Some of the experiments on pastes are given in the following table:

1,650 was B.O.T. paste. Its readings are given in terms of 1,615, the B.O.T. standard. The other pastes are given in terms of 1,650. Columns one, two, and three are not corrected for the variation of 1,650, as from the readings of 1,653, 1,654, and 1,654, it looks as if the B.O.T. cell had been varying owing to alterations of density of the zinc sulphate solution.

1,651.—Paste given to me by Mr. Fox Bourne. The bottle had Becker's label, but the paste was grey like that of Hopkin and Williams, from whom Mr. Fox Bourne had also bought sulphate. It was always far too high.

1,652.—Paste of basic mercuric sulphate. This was always very low. This goes to show that basic mercuric sulphate is harmless, so that mercuric sulphate may perhaps be rendered harmless by washing it thoroughly.

1,653.—Paste made by dissolving mercury as already described. It began low, gradually coming to be too high on shaking.

1,654.—Paste made by precipitating mercurous nitrate with zinc sulphate. This is quite white unless copiously washed, then it is slightly yellow owing to the presence of basic protosulphate. Tap water containing chalk must not be used for washing. This paste contains no mercuric salts. To test the pastes for mercuric salts, they were shaken with water and the solution precipitated with salt and filtered. The filtrate was tested with hydrogen sulphide and with potassium iodide. This paste seem right.

1,655.—Paste bought in 1891 from Becker. This was a white powder, and remained white as paste. Contained no persalt. Gradually fell to normal. The pastes nearly always give high readings after stirring up well.

1,656.—Paste from Hopkin and Williams, 1891. Powder, grey, turning yellowish in the paste, contains a good deal of persalt. This is the paste generally used for cells. Two other specimens bought from the same firm some years ago also contained persulphate. The paste begins very high, gradually falling. Washing out the persulphate may help this. I do not know if sodium formate could be used to reduce the persalt.

1,657.—Paste from Griffin. Grey powder. Contains a great deal of persalt. On July 24th, 1891, excess of zinc carbonate was added to this paste It frothed up and remained as a sort of sponge. The reading then fell gradually till it was too low.

1,658.—Paste made by slow electrolysis. M Potier has proposed a cell made by using a mercury anode and cathode in zinc sulphate; but I have not the reference. The zinc amalgam is, of course, too weak unless a great deal of electricity is passed through. The paste formed is the yellow basic mercurous sulphate. The reading was too high first, and fell to nearly normal. Finally a little acid was added on August 2nd, 1891, and the reading was very high. I made other unsuccessful experiments on Potier cells.

1,612.—H cell with 2¼ per cent. amalgam. It was always low, probably because its solution was saturated at both poles. Of course, as this was a complete cell, it was compared direct with the B.O.T. cell, and as the temperature coefficients are different, and as there are other causes of variation, it is impossible to say which was at fault. Readings like those of 1,654 may be got with pastes, but not with different kinds of cell.

1,674.—Becker paste, 1888, with zinc carbonate.

1,675.—Same without carbonate. Probably there was not enough carbonate to convert the whole of the sulphate into basic salt. Lord Rayleigh recommends the addition of a very small quantity of zinc carbonate to the paste. If the paste has persulphate the carbonate will first convert it into basic persulphate, which appears to be harmless. An excess of zinc carbonate will, of course, waste the mercurous sulphate.

1,679.—Complete cell with Becker paste; put in dry.

1,681.—H cell. Becker paste.

1,685.—Paste made by electrolysis in acid solution.

1,688.—Tube cell, with precipitated mercurous sulphate, made in 1888.

It will be seen that the cells seem to tend towards a common value, but that is almost all that can be said.

The Board of Trade circular directs the paste to be rubbed up with mercury. This would tend to reduce the persulphate to protosulphate. Mercury cannot be rubbed up with protosulphate, as it does not oxidise the surface, so the mercury is not "killed," and collects in a globule. The mere fact of the mercury mixing shows that the sulphate is bad.

MERCURY.

To test the effect of impurities, some amalgam containing silver, copper, and zinc was taken. Sodium amalgam was added, and the whole shaken up with salts of lead, iron, antimony, platinum, and tin. The amalgam was then shaken up well with persalts of mercury. The mecuries to be tested were put in little crucibles in a solution of mercurous nitrate. After a few minutes they all agreed.

TEMPERATURE COEFFICIENTS.

The temperature coefficient of several cells was taken with some care. Three cells were tested first. They were put in a bath at about 30deg. C., the temperature being taken at each reading, and the water slightly stirred.

1,682	0·000312	and	0·000340
1,684	0·000861	,,	0·000840
1,683	0·000297	,,	0·000308

The reason for the discrepancy between the first and second reading of each cell is clear; the cell was colder than the water at first, then, as the cell warmed and the water cooled, the cell was left a little hotter than the water in which the thermometer was placed. Some days later the following readings were taken. In this case I kept the temperatures nearly constant by adding hot water.

1,680	0·000287	1,685	0·000492
1,682	0·000421	1,688	0·00085
1,683	0·000324	1,689	0·00042
1,684	0·000756		

Of these cells, 1,680, 1,683, 1,689, had dilute solutions, made up of equal weights of water and $ZnSO_4 \cdot 7H_2O$. 1,680 and 1,683 differed only in the mercury paste; 1,683 gave different coefficients on the two days. The variations in the other cells may be easily explained. If a cell with the zinc at the top has its solution saturated at, say, 15deg. C., and is then heated, the solution round the zinc is no longer saturated. The temperature coefficient of the cell depends on its past history in fact, and is lower in spring than in autumn. An H cell, or a tube cell, with crystals of zinc sulphate in contact with the zinc always has its solution saturated at both plates. 1,682 is an ordinary cell, but the zinc is at the top, hence its low temperature coefficient when heated. If left at 30deg. C. for a few weeks and then cooled, no doubt its temperature coefficient would rise to 0·0008 or 80. 1,684 is an H cell with crystals in both legs 1,685 is an electrolysis cell, with zinc at top. 1,688 is a tube cell, with crystals in both tubes, hence its high coefficient. It is thus clear that the temperature coefficient of a cell may vary from day to day according to its treatment, and may, perhaps, vary 100 per cent. between winter and summer. Even a variation between ·0008 and ·0006 means an error that may in extreme cases amount to something like a half per cent.—that is, it may be outside the limits I have here taken as worth considering. My water bath differed some two or three degrees from one evening to another, and, no doubt, varied more during the day and night. A new cell would thus be saturated at, say, 20deg., while the standard was saturated at, say, 15deg. If the coefficient of one was 0·0008, and of the other 0·0004, the error might easily be 0·0012 due to that alone. To avoid this difficulty the solution must be kept saturated by using the H or tube cell. Some authorities push the zinc into the paste. This may give the same result, but the zinc then amalgamates too much. Sometimes it has beads of mercury hanging to it, and if these are the only surfaces exposed the E.M.F. may be too low. Over-amalgamation also often detaches the zinc by weakening the solder. Moreover, the formation of so much zinc sulphate may use up all the water, thus rendering the cell dry, or producing a less hydrated salt.

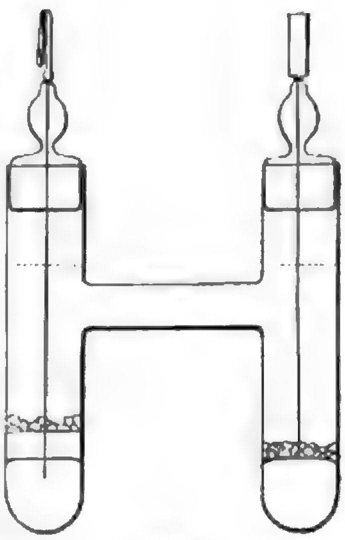


FIG. 1.

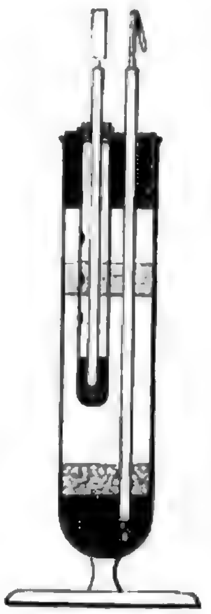


FIG. 2.

It would seem better to use a weaker solution. Prof. Carhart and others have proposed saturating at 0deg. C. It seems much simpler to use a standard solution of sulphate made by weighing. There is no particular advantage in saturating at 0deg. C. Weak solution cells have the very great advantage of low internal resistance. No doubt, crystals of zinc sulphate also lessen the available surfaces of the metal and lessen the current that can be taken without polarisation. The construction of the H cell is shown in Fig. 1. One leg contains amalgam with crystals on it, and the other paste. Platinum wires are sealed through glass stoppers, and end in little bracelet snaps. The stoppers are smeared with vaseline to prevent creeping. Fig. 2

is a tube cell. A test tube with a foot has a cork with two holes in it. Through one of them the tube with internal wire is led to the bottom. The mercury and paste are poured in through a funnel. The zinc tube is then pushed through the larger hole in the cork: it contains the amalgam, and has three holes in the side. It is strong to resist fracture. Solution is poured in gently above the level of the first hole. Rangoon oil is poured in over the level of the second hole. The third lets the air out. The zinc connection is then put in, with its cork fitting the smaller tube. If the solution is saturated, the inner tube must be long, so that the zinc surface is on a level with the crystals on the paste. If a dilute solution is used, the inner tube is shorter. This form of cell is convenient for immersing in a bath, and the zinc tubes can be taken out and changed, or tried in other cells.

Prof. Carhart mentions the effect of pressure on Daniell cells. I tried exhausting a Clark cell a third of an atmosphere, and raising its pressure, but though that must have affected the tendency of the liquid to evaporate, it made no perceptible difference in the reading.

CITY NOTES.

Brazilian Submarine Telegraph Company.—The receipts for last week amounted to £4,186.

City and South London Railway.—The receipts for the week ending 22nd inst. were £728, against £653 for the week ending 15th inst.

Electric Installation Company.—Letters of allotment in the Electric Installation and Maintenance Company, Limited, for the supply of electricity to the Crystal Palace, Sydenham, and district, have been posted.

The London Platino-Brazilian Telegraph Company announce that the half-yearly coupon on the 6 per cent. debentures, due on September 1st, will be paid by Messrs. Glyn, Mills, and Co., Lombard-street, E.C.

Western and Brazilian Telegraph Company.—The receipts for the week ending August 21, after deducting 17 per cent. of the gross receipts payable to the London-Platino Brazilian Telegraph Company, were £2,812.

New Company.—The Electric Welding Company, Limited, has been brought out at last. The capital has been put at £460,000 in 25,000 ordinary £10 shares and 1,000 founders' shares of £10. One-third of the ordinary shares are taken by the vendors, and the remainder are offered to the public - that is, the vendors are to have £83,330 worth of shares. The Board is made up of the following names: Sir George Barclay Bruce, past president of the Institution of Civil Engineers; E. Ashmead-Bartlett, Esq., M.P., 6, Grosvenor-street, London, W.; Captain A. H. Chapman, J.P., Messrs. Clarke, Chapman, and Co., Victoria Works, Gateshead-on-Tyne; Wm. F. Gooch, Esq., J.P., managing director of the Vulcan Iron Works Company, Limited; Joseph Kincaid, Esq., M.I.C.E., director of the York Engineering Company, Limited. The consulting engineer is Sir Frederick Bramwell, Bart., F.R.S., past president of the Institution of Civil Engineers, 5, Great George-street, Westminster. The prospectus states that "This Company has been formed to acquire the British patents in respect of Prof. Elihu Thomson's inventions for the electric welding and working of metals." One of the welding machines can be seen at work at the Company's depot, Fanshawe-street, Hoxton.

PROVISIONAL PATENTS, 1891.

August 17.

13865. **Improvements in apparatus for giving notice, by means of electricity, of the heating of bearings.** Edmund Edwards, 35, Southampton-buildings, London. (Anton Backhaus, Germany.)

12880. **Aero dynamic motive power apparatus.** Joseph Desmaroux, 53, Chancery-lane, London.

August 18.

13917. **Improvements in telegraphing.** Daniel H. Smith, 141, Bath-street, Glasgow. (Complete specification.)

13926. **Improvements in electric locomotives and in electric conductors for use therewith.** Llewelyn Birchall Atkinson, Claude William Atkinson, and Frederick Hurd, 1, Queen Victoria-street, London.

13927. **A unison apparatus for printing telegraphs.** Henry Van Hoevenbergh, 1, Queen Victoria-street, London.

13936. **Improvements in and relating to electric motors, chiefly designed for use in connection with ventilating fans.** Charles Jacob Kintner, 45, Southampton-buildings, London. (Complete specification.)

13942. **Improvements in or connected with apparatus for completing and interrupting electric circuits.** Thomas Parker, John Harold Woodward, and Edmund Scott Gustave Rees, 47, Lincoln's-inn-fields, London.

August 19.

13961. **Appliances for an electrical parcel exchange system.** Alfred Rosling Bennett, 22, St. Albans-road, Harlesden, London.

14023. **Improvements in electrometers.** Carl Raab, Temple-chambers, London.

14040. **Improvements in electric lighting and extinguishing apparatus for gas-burners.** Henry Harris Lake, 45, Southampton-buildings, London. (Axel Orling, Sweden.)

14042. **Improvements in electric lampholders.** Oscar Thomas Cooper, 54, Fleet-street, London.

August 20.

14063. **Improvements in telephonic transmitters.** Alexander Marr, 70, Market-street, Manchester.

14067. **Improvements in moulds and machinery for the manufacture of glass switch-slabs for electrical and other purposes.** Dan Rylands and Benjamin Stoner, Shopcote House, Stairfoot, near Barnsley.

14084. **Improvements in electrically actuated time-checking apparatus** Joseph Appleton and William Thomas Burbey, 77, Chancery-lane, London.

14089. **Improvements in electrical measuring apparatus.** Anthony Reckenzaun, 11, Furnival-street, London.

14096. **Combination electric lock** James Graham Thompson, 23, Southampton-buildings, London.

14097. **Improvements in telephone transmitters, and the methods adopted for the transmission of articulate speech, musical, and other sound-waves.** Herbert Luzerne Todd and John Todd, 13, King-street, Cheapside, London.

14134. **Improvements in thermo-dynamic machines, and in apparatus and appliances connected therewith.** William Henry Watkinson, 15, St. James's-row, Sheffield.

14150. **Improvements in electric fire detectors or alarms.** Harwood Morgan, 55, Chancery-lane, London. (Charles Dion, France.)

14171. **An improvement in car conductors from overhead for electric cars** George Sylvester Grimstone, 28, Southampton-buildings, London.

August 22.

14217. **A new or improved printing telegraphic apparatus.** Sacco Gospare and Luigi Giacomini, 54, Castle-street, London.

14234 **Improvements in and relating to electric railways** Michaelangelo Cattori, 45, Southampton-buildings, London. (Complete specification.)

14236. **An improved method of arranging apparatus for generating and distributing electricity by alternating currents.** Henry Robert Low and George Edward Barker Pritchett, 41, Beaconsfield-road, Twickenham.

SPECIFICATIONS PUBLISHED.

1882.

4303. **Electrical storage batteries.** Frankland. (Second edition. 6d.

1888.

9745*. **Electric motors.** Manville. (Amended.) 8d.

1890.

1306*. **Galvanic dry elements.** Smith (Holleson). (Amended.) 6d.

12209. **Electric meters.** Heurtey and others. 11d.

12330. **Thermo-electric batteries.** Gouraud (Dickerson). 6d.

13199. **Electric telephone systems.** Graham. 11d.

14693. **Galvanic battery.** Bayly (Silicco). 6d.

15328. **Heating by means of electric currents.** Zipernowski. 6d.

15536 **Telephone receivers.** Collier. 8d.

15792. **Incandescent electric lamps.** Mills (Edison). 8d.

16792. **Electric arc lamps.** De Puydt. 8d.

1891.

1192. **Propelling boats, etc., by electrical energy.** Busser. 8d.

7160. **Incandescent lamps.** Walter. 6d.

11118 **Electrical signals for steam vessels.** Clark (Tucker and another). 8d.

11145. **Printing telegraph instruments.** Bates and Hoovenbergh. 6d.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Brush Co.	—	2¼
— Pref.	—	1½
India Rubber, Gutta Percha & Telegraph Co.	10	19½
House-to-House	5	5
Metropolitan Electric Supply	—	10
London Electric Supply	5	1⅞
Swan United	3¾	4½
St. James'	—	6⅞
National Telephone	5	4⅝
Electric Construction	10	7½
Westminster Electric	—	5

NOTES.

Russian Exhibition.—An international exhibition is announced, under the auspices of the Russian Government, at Odessa in 1894.

Lignite.—The use of lignite as a substitute for coal, from which great things were expected in Italy, has proved not to have the value claimed.

Melun.—Negotiations are in progress between the Municipality of Melun, France, and the local company for lighting the public lamps by electricity.

People's Palace.—It has been decided to light up the People's Palace at Whitechapel with electric light. Messrs. Slingo and Brooker are to superintend the installation.

Dissolution of Partnership.—We see it announced that Messrs. Johnson, Matthey, and Co., Hatton garden, the well-known assayists and metallurgical chemists, have dissolved partnership.

Change of Offices.—The Brush Company are, we understand, removing their central offices from Belvedere-road to their premises opposite the Mansion House Station, in Queen Victoria-street.

Carbon Works.—As will be seen from our advertisement columns, Messrs. Wheatley Kirk and Co. have for disposal a small compact works, with engine, presses, grinding plant, and furnaces for manufacture of carbon, with stock of material, as a going concern.

Guernsey Electric Railway.—As the Channel Islands are outside the provisions of the Board of Trade, the supervision of the erection of the line is being carried out by the Special States Committee, who have appointed Mr. Bernard Drake as their electrical adviser.

Testing Cell.—The Mining and General Electric Lamp Company are now making a very small lithanode cell, suitable for testing purposes. The total weight is 2½oz., including terminals and electrolyte. Its capacity when discharged at the rate of ·1 ampere is one ampere-hour.

Helmholtz Medal.—In commemoration of Prof. Helmholtz's seventieth birthday a medal like that of Copley is hereafter to be struck by the Berlin Academy. It will bear the portrait of the *savant*, and is to be given every two or three years as a reward of merit to an eminent German man of science.

Sunderland.—An application was made by Mr. R. J. Charlton to the Sunderland Town Council for permission to lay a pipe across the street, underneath the carriageway, for the purpose of conveying an electric wire from Mr. Thornton's Theatre Royal to Mr. Laing's bar. The matter was referred to the Electric Lighting Committe.

Electric Dinner Effects.—At the dinner given during the recent visit of the French Navy to Portsmouth, some striking effects were obtained at the dinner table in the Jan Van Beers' style, by lighting up the table (which was of glass) underneath, so as to glow in the "red, white, and blue" of the familiar tricolour. The idea was duly applauded.

Books Received.—"The Electromagnet and Electromagnetic Magnetism," by Silvanus P. Thompson, D.Sc., B.A., F.R.S., published by Messrs. E. and F. N. Spon; also "Electricity in Mining," by the same author and publisher. This latter pamphlet gives the full text of the author's lecture at Cardiff during the recent meeting of the British Association.

Cables to Brazil.—France and Brazil are now in telegraphic communication with each other *viâ* the Antilles. On Wednesday the first official message was transmitted over the cable congratulating President Carnot on the fact. On the same day the first direct cable between the United States and Brazil, stretching from Punta Rassa, Florida, to Para, was opened.

Paris Telephone.—M. Jean P. A. Martin, member of the Association of French Stenographers, writes to the *Times* bearing his testimony to the efficiency of the Paris-London telephone, which he uses every day, but wishing to know why, when telephoning is perfectly distinct between London and Lyons, redtapeism or other cause prevents the use of the line direct to Lyons.

Shoreditch.—On Tuesday the Shoreditch Vestry, Mr. N. Moss, L.C.C., presiding, decided to obtain power to supply electricity within the parish of Shoreditch for public and private purposes; and to memorialise the Board of Trade for a provisional order under the Electric Lighting Acts, 1882 and 1888, to enable the Vestry to supply the parish or any part thereof with electricity.

Salford.—The Salford Borough Council, on Wednesday, adopted a resolution of the General Health Committee accepting the tender of the Manchester Edison-Swan Electric Lighting Company for the electric light installation required at the sanatorium, in accordance with specifications prepared, for the sum of £1,312. Mr. Alderman W. Robinson said that they would save £300 by adopting the system proposed.

Missing Letters.—Our readers will doubtless have noticed in the daily papers this week the statement that a large number of letters have never reached their destination, and that over 2,000 have been just discovered. Among these were some addressed to this office. If any of our correspondents have sent any important communication which has not been attended to they would do well to communicate again.

Waterfalls.—The *Moniteur Industriel* states that an English syndicate is visiting France to investigate the various falls of water with a view to purchase. The price of waterfalls is evidently likely to go up now that light, power, and heat can be so easily manufactured out of their hydraulic power. The French papers remind their readers that a good waterfall has now become to all intents and purposes an "everlasting coalfield."

A Fire Detector.—A neat and simple fire alarm has recently been devised, consisting of a stud placed in a porcelain base and surrounded by, but not touching, a knob of fusible metal of considerable surface projecting into the room. The electric circuit is arranged to energise a relay on the slightest contact of the metal with the stud, and the whole is so cheap that they might be placed in every room of a mill or public building at small cost.

Partnership.—Mr. J. Edward Waller, who has for many years been associated with Mr. Joseph Kincaid as his manager, has entered into partnership with Mr. Edward Manville, consulting electrical engineer. Messrs. Waller and Manville will carry on at 39, Victoria-street, Westminster, S.W., the profession of consulting civil and electrical engineers, a desirable combination in the rapidly-advancing condition of the applications of electricity.

Obituary.—We much regret to have to record the death of one of the members of the Old Students' Association, at the age of 22, Mr. George T. S. Müller, who was well known to most of the members of the above-named association, as he was one of the most regular attendants at meetings and social events. While bathing at Hampstead on Friday morning, August 28, being suddenly seized with cramp he sank, and was drowned before help could be given.

Magnetic Variation.—The hydrographic department of the Government has given notice of a curious error in one of the Admiralty charts, the correction of which is of importance to mariners navigating Liverpool Bay. It appears that in certain copies of the Admiralty plan, No. 1,951, for Liverpool Bay, it is stated that the magnetic variation taken in 1888 increases 9deg. annually. This should be altered to "Magnetic variation in 1888 decreasing 8deg. annually."

Electric Railways in France.—The General Council has granted the concession for the extension of the electric tramway from Montferrand to Clermont, to Royat, and to the summit of Puy-de-Dôme. This project comprises the adherence system, the gear system, and the cable system. It is expected that within 18 months the formalities and necessary works will have been completed, and that excursionists and visitors will be able to make the ascension of Puy-de-Dôme by railway.

Visit to Frankfort.—It is announced that 20 members of the Electrical Trades Section of the London Chamber of Commerce have arranged to depart for Frankfort on September 6. The president of the Electrotechnical Congress has written to assure them of welcome, and to mention that tickets for the congress will not be sent, but will be given on personal presentation at the office of reception opposite the railway station. Other members not mentioned on the list may also obtain tickets on application.

Shrewsbury.—At the Shrewsbury Town Council last week Mr. S. M. Morris moved that the consent of the Council be granted to the application of the Shropshire Electric Light and Power Company, Limited, to the Board of Trade for a license to erect and maintain electric lines and works, and to supply electricity within the borough of Shrewsbury, subject to power being reserved for the Council to purchase at the end of either seven, fourteen, twenty-one, twenty-eight, or thirty-five years, at a price to be agreed upon by arbitration. This was seconded by Mr. T. M. How, and, after a brief discussion, agreed to.

Gas, Water, and Electric Light Directory.—We are in receipt of the "Gas, Water, and Electric Lighting Companies' Directory for 1891," edited by Charles W. Hastings, and published by Hazell, Watson, and Viney. The work contains an account of every town with gas, water, or electric light, with very full particulars of formation of company, capital, dividends, names of officers, population, and so forth. The work should be extremely valuable as a book of reference to those interested in municipal lighting questions. There is also a useful chapter on the rating of these companies.

Free Telephones.—The Consolidated Telephone Construction and Maintenance Company, Limited, are advertising that they—the sole manufacturers of telephones for all the exchange companies in the United Kingdom since the year 1881, as also sole manufacturers of telephones for use abroad since the same year—can, by an agreement with the National Telephone Company, Limited, of Oxford-court, Cannon-street, London, supply telephones of all kinds under the Crossley, the Gower-Bell, the Hunnings, the Blake, and their kindred patents, for sale outright, free of all royalties and all claims whatsoever.

Substitutes for Platinum.—Another substitute for platinum as regards similarity of coefficient of expansion with that of glass is announced, the discovery of Mr. R. A. Fessenden, of Roseville, New Jersey. This consists of an alloy of iron, nickel, cobalt, silicon, and gold or silver. The advantage claimed is for the manufacture of vacuum tubes, but it is very evident that if in the near future incandescent lamps are to be as cheap as lamp glasses, the reduction in the cost of connections in the substitution of some alloy for the expensive platinum, now solely used, would prove a most important element in the case.

Electric Light and Fishing.—A correspondent of *Land and Water* states that fishing all along by Totland Bay, Isle of Wight, was always poor, but that since the setting up of the search-light for the forts it has become worse. He also heard that there used to be a very good place for fish near the lighthouse at St. Catherine's Point, but that the electric light has driven them all away, and that now it is quite useless putting out nets in a spot where a few years since a decent haul was looked on as a certainty. He solicits opinions on this matter from those who are more versed in sea fish and their ways than he is himself.

Lightning at Keighley.—On Friday a heavy thunderstorm broke over the town of Keighley, accompanied by heavy rain, and a cottager and his family had a narrow escape. About half-past four o'clock the man, whose name is Bartle, was awakened by a thunderclap, and found that the bedroom was a mass of flame. His wife and family, who were also asleep upstairs, jumped up in a state of great alarm, but beyond a black eye, received by Bartle himself, and a slight injury to his wife's arm, no personal damage appears to have been sustained. The house windows were for the most part shattered, along with parts of the woodwork.

Electric Fittings.—The influence of the spread of electric lighting is nowhere more forcibly shown than in the way the trade in gas fittings is slowly but gradually dwindling away, leading many hitherto exclusively gas fitting firms to go into electric fitting. Amongst these, Messrs. E. Emanuel and Sons, Limited, of 4, High-street, Marylebone, are turning their attention to electric switches and lamp fittings. We have recently called at their showroom and were shown some handsome switchboards on slate in teak cases, fuses, wall plugs, and other apparatus. They also keep in stock brackets, electroliers, and table lamps in brass and hammered iron.

Galvanic Action in Ice Cream Machines.—A new danger has been discerned due to unsuspected electrical action. Dr. G. S. Hull, it is stated, has recently carried out experiments with ice cream freezers, and he finds that electrolytic action takes place between the freezer and the paddle when the ice cream and fruit salts are introduced, which results in the production of poisonous salts of copper and zinc. This is probably the explanation of the mysterious deaths by poisoning which have resulted from eating ice cream. The remedy is easy: the freezer and mixing paddle should be of the same material. Journals circulating in hot climates would do well to widely circulate the knowledge of this fact.

Canterbury.—At the Canterbury General Purposes Committee it was stated that the town clerk had communicated with the Dover Town Council, who were in the same state as Canterbury, having only heard from the Brush Company. Mr. Wells wanted to know whether there was not a ring of the companies. Mr. Cross said that the Brush Company's offer should be considered, and a definite conclusion come to at once. Alderman Mount said he would put a proposal forward at the next meeting to this effect. He said the company had offered to repay the £200 paid for the provisional order, and to carry out the work without charging a penny or asking for the public light contract. What the Council could want better than that he did not know. The matter then dropped.

Column Printing Telegraph Machines.—A writ was on Saturday served on the Exchange Telegraph Company by the solicitors to the Column Printing Telegraph Syndicate, Limited, in respect of an alleged infringement of the Column Syndicate's patents, and a notification has been issued to all users of the alleged infringing machine that they are legally liable if they continue to use the instrument. The allegation of the plaintiffs is that they have the only practical column printing telegraph instrument in existence, and that the Exchange Telegraph Company had not been able to make a machine under their own patent to accomplish the same results, or to work satisfactorily, until they had infringed a material part of the instrument belonging to the Column Printing Syndicate.

Electric Tanning Patents.—An interesting point to patentees and commercial men in general has arisen with regard to the patents of the British Tanning Company. The patents for a process of electric tanning granted in Paris to Messrs. Worms and Balé were also taken out in America and in Great Britain and Ireland. By some error the United States patents were published prior to the British patents, and these became invalidated, and were the subject of an adverse decision in the Chancery Courts last January. The company might have availed themselves of the Act of Convention, by which the date of the American patent could have been put back to that of the French patent. But they have adopted the other course open to them, and a special Act of Parliament has been passed, which received Royal assent on July 28th, the effect of which is to restore the patent rights.

Telephones and Coast Guard Telegraphs.—At the meeting of the Associated Chamber of Commerce in Dublin, on Wednesday, a resolution was proposed by Mr. Plummer, of the Newcastle and Gateshead Chamber, to the effect that as the telephone patents are expiring, the Post Office should be communicated with, to place the telephonic system of the country under such regulations as would give the public the greatest facilities. An amendment by Mr. Massey, of Hull, suggesting that the matter was one for local enterprise, was, after a good deal of discussion, unanimously adopted. On the motion of Captain Bailey, of Plymouth, seconded by Mr. Hunter, and supported by Sir Henry Waring, the association expressed its conviction that the coast guard stations, the shore and rock lighthouses, and the lightships of the United Kingdom, should be placed in telegraphic or telephonic communication with the general telegraph system of the country.

Accident to Train-Lighting Dynamo.—A singular accident occurred on Thursday last week to the 9.17 Great Northern train from Barnet to Moorgate-street. The carriages are lighted by electricity, the current being supplied by a dynamo placed in a special compartment attached to the rear guard's van. Soon after the train left the Finchley Station, the rear guard discovered that flames were issuing from the electrical chamber, and that fire had taken considerable hold of the woodwork. By opening the air-valve, he released the vacuum brake, and brought the train to a standstill. A gang of porters were quickly on the spot; and by the plentiful use of water, they subdued the fire. A telegram was despatched to Finsbury Park, where an electrician met the train. It was then found that the dynamo was intact, and the light was available for the remainder of the journey. It is conjectured that undue friction in connection with the dynamo had set light to the woodwork of the chamber.

Odessa.—Her Majesty's Consul-General at Odessa (Mr. T. B. Sandwith), writing to the Foreign Office, mentions that the port of Odessa (in contradistinction to the town of that name), having for many years remained unlit even by oil lamps, and within two years only being lit by gas, has at length been illuminated by electricity. An installation has been completed at a cost of 80,000 roubles (£8,400). This consists of 64 arc lamps of 2,000 c.p. each, and of two lanterns, one at each end of the breakwater which runs the whole length of the port. The illuminating power is generated by two of Willans's vertical engines of 67 h.p. each. The Odessa Town Council has assigned a sum of 20,000 roubles (£2,100) annually for the working expenses. The new installation is regarded as a great boon by the shipping interest, the whole port being brilliantly lighted, so as to admit of the loading and discharging of steamers by night as well as by day.

Electrolytic Separation of Zinc.—The process introduced by M. Nhansen may be applied to the electrolytic separation of zinc by employing a bath, the temperature of which can be lowered according to the density of current employed. The inventor notices that the temperature must be lowered as the density of current is reduced. The mean of 120 observations is shown in the following table:

Density in amperes	State of metal obtained.			
	10deg.	20deg.	30deg.	40deg. Cent.
10	compact	spongy	spongy	spongy
50	—	semi-comp	—	—
100	—	compact	semi-comp	—
150	—	—	compact	semi-comp.
200	—	—	—	compact

If it is desired to work with a density of "100 per square metre," the bath, to obtain compact metal, must be kept about 20deg. C. In commercial practice it is always preferable to use currents of less than 50 amperes density, and to maintain the temperature below 10deg. C. by means of ice or refrigerating apparatus.

Electric Melting and Welding.—A new claimant for honours in electrical welding or forging is receiving attention in Boston, according to the New York *Electrical Review*. An exhibition was recently given by Mr. George D. Burton. The Press accounts state that one experiment was the melting into liquid form of a bar of steel an inch in diameter and 12in. long in 45 seconds, without the temperature of the room being raised a single degree from its normal condition. Another thing shown was the making of a steel railroad spike. The bar was cut into the required length, the pieces passed through the electrical machine, where one end was heated, and then to a die, which shapes the head on to the heated end, the point being compressed into the shape without heating. Another exhibit was the forming of an auger screw, the flat bar of iron being fastened in the machine at the two ends and heated almost instantly, and then twisted into the required spiral by the automatic turn of the machine. These experiments were witnessed by Dr. W. H. Wahl, Prof. Van der Weyde, and others.

Crystal Palace Exhibition.—The Crystal Palace Electrical Exhibition, to be opened on the 1st January next, has now received the sanction of the Board of Trade, and is duly certified as an international exhibition, under the provisions of the Patents, Designs, and Trade Marks Act, 1883. This Act provides for the publication of any description of the invention during the period of the exhibition, or the use of the invention for the purposes of the exhibition, or its use by any person elsewhere without the privity or consent of the inventor, without prejudicing the right of the inventor to apply for and obtain provisional protection, and a patent within six months of the opening of the exhibition. The right of application for registration of designs is also protected by this Act for a period of six months from the opening of the exhibition. The exhibits of her Majesty's Government will include historical telegraphic and electrical apparatus, instruments, and appliances, as well as the modern apparatus and instruments now in use in the Postal Telegraph Department. This exhibit will be arranged under the direction of Mr. W. H. Preece, F.R.S.

Lightning Conductors.—It may be remembered that in the spring of 1888 Prof. Oliver Lodge, F.R.S., gave two lectures on "Lightning Conductors" to the Society of Arts, in which he promulgated several revolutionary views on the subject, and supported them by a series of direct experiments with Leyden jars. The experiments also branched off into a study of electric waves, a subject which was being simultaneously worked at in Germany by Hertz. At the British Association meeting in Bath that same year, Prof. Lodge's views were goodnaturedly controverted by Mr. W. H. Preece, partly for the purpose of raising a discussion and partly because some of them were rather startling. Since then a more complete communication from Prof. Lodge to the Institution of Electrical Engineers and to many scientific periodicals, as well as a recent paper read before the Royal Society, are generally held to have fairly substantiated the new views, and we understand that during the present year Prof. Lodge has been engaged in welding together the principal portions of all this literature, with sundry additions, and that Messrs. Whittaker and Co. propose to issue it as a large volume of the Specialists' series in the course of the autumn.

Bolton Technical School.—The careful consideration of the Bolton Technical School Committee has been given to the question of engines, and they have decided to put down the Griffin double-acting gas engine of Messrs. Dick, Kerr, and Co., Kilmarnock and London. In this engine there is an explosion every revolution, first on one side of the piston head and then the other, which ensures great regularity in running. The consumption of gas in these engines is stated to be as small as in best single-acting engines. Two engines are required, each to indicate 35 h.p. One will be used to work the machinery and the other the electric lighting, but they will be so arranged as to be worked separately for either purpose, so that any accident to either engine would not completely stop any part of the work of the school. In addition to the large engines, a 3-h.p. engine will be provided, and serve as a starting engine for the large ones, and also will be available for use when it is required to run only a small portion of the machinery. This will enable students to use some of the machinery for special purposes without the necessity of running the large engines, and will be a great convenience in the effective working of the school.

Manchester.—At a meeting of the Manchester City Council on Wednesday, Mr. Brooks moved the approval of the proceedings of the Gas Committee, together with a resolution to apply to the Local Government Board to sanction the borrowing of £150,000 for the purpose of carrying out the electric lighting scheme of the Corporation. Sir John Harwood, in seconding the resolution, said that for some time the committee had been taking the opinion of the best men in the country as to the best mode of putting down an installation of electricity. They consulted a considerable number of the best-known electrical engineers, and that morning he had a final conference with Dr. Hopkinson, who, he believed, was one of the best authorities in this country. The whole of the arrangements had been placed in his hands. The scheme would involve oversight for 12 months after it was finished. The engineers of the hydraulic power and electricity schemes would work in harmony, and they expected that under the same rule, and very largely under the same administration, they should be able to have the same motive power, so far as steam was concerned, driving those two forces, and producing for Manchester the very best modern approved form of both hydraulic power and electricity. The resolution was adopted.

Artificial Production of Rain.—Within the last three weeks, according to the New York correspondent of the *Standard*, nine showers of rain, of which one was considerable, have been artificially produced in a region almost rainless normally. The district selected for experiment by the United States Agricultural Department is near the midland staked plains of Texas, a grazing country, where agriculture is impossible because of the aridity of the climate. For more than three years no rain has fallen there, except in very occasional small showers. On Wednesday the vegetation was parched, the sky unclouded, the barometer at 30·5, the hygrometer between dry and very dry. The cowboys, who are shrewd judges of the weather, declared that rain was impossible. With this condition of the atmosphere the following experiment was tried: Five balloons, each 12ft. in diameter, and charged with one-third oxygen and two-thirds hydrogen, were exploded by electricity on time fuses, at heights ranging from 1,000ft. to five miles. Three hundred and fifty pounds of Racka-rock dynamite was also exploded in scattered packages of from 10lb. to 20lb., at intervals of one minute, ending at 10 p.m. At three o'clock the next morning a sharp clap of thunder was followed by heavy rain. At sunrise a beautiful rainbow was seen. The rain stopped at eight o'clock, but began again to fall after more explosives had been used.

Cause of Heat in Electric Welding.—According to Prof. Elihu Thomson, says an exchange, it is not the extra resistance at the break that gives rise to the heating in electric welding. The imperfect contact there no doubt hastens the heating of the joint, but a solid bar placed between the clamps of an electric welding machine can also be raised to the welding temperature. The real cause of the concentration of the heating between the clamps is the relatively greater conductivity of other portions of the welding circuit, which is usually composed of massive copper conductors, kept cool in the case of large work by the circulation of water. By keeping the conductors cool in this way their resistance is maintained constant, and an accentuation of heating effect follows at the joint where the rise in temperature increases the resistance. In large works it has been found that hydraulic power can be advantageously employed both for clamping and making contact with the pieces to be welded or worked. In dealing with metals such as lead, tin, zinc, the temperature required for welding is so low that the metal never glows, and the progress of the breaking cannot be watched with the eye. By properly shaping their ends, leaden water-pipes can easily be welded together end to end. The meeting edges should be thinned so as to reduce the surface of contact below the area of the pipe wall. Joints thus made are very good and sound. Most metals can be welded without the use of a flux, but for good work a flux is often desirable.

The Marvin Electric Drill.—The Marvin electric percussion drill, a recent American invention, consists of an iron bar, to which a drill is connected, reciprocating axially between two solenoids intermittently energised by pulsations of current delivered to the two coils in alternation over separate circuits from a special dynamo. The two solenoids are mounted in a boiler tube casing, and the whole apparatus is mounted upon an adjustable support. As the coils are alternately supplied with pulsations of current over separate circuits from a special dynamo, no commutating devices or sliding contacts are required either upon the drill or in its vicinity. The moving parts are simply an iron rod travelling axially, and a ratchet arrangement that serves to turn the drill slightly at each stroke. The whole machine is designed to endure the roughest kind of abuse in mines and quarries. The machines now ready are capable of drilling holes from 1ft. to 8ft. deep, and from 1in. to 2in. in diameter. They will cut about 8ft. per hour in granite, and require about 5 h.p. The drill travels in synchronism with the dynamo, and by feeding the machine up to the rock the stroke may be made as short as is desired for starting a hole, while the number of strokes per minute remains the same. A peculiar property of the machine is that when the machine is withdrawn out of striking range of the rock the plunger immediately loses its stroke. It takes up a position about midway between the coils, and its motion becomes a more quivering. There is no pounding against buffers, as the rod is perfectly cushioned by the magnetic action of the coils. At full stroke the drill has an excursion of about 4in., and strikes 650 blows per minute. It is of about the same weight and bulk as an air drill of the same capacity.

Arbroath.—The electric light has just been introduced in a practical form into Arbroath by Mr. Andrew Lowson, flaxspinner and manufacturer. The installation has been carried out by Messrs. Lowdon Bros., Tay-street, Dundee, and the work having now been completed the light was last week submitted to a final test. The installation is similar in most respects to numerous others fitted up in the district by the Messrs. Lowdon. The total number of lamps is about 300, these being distributed over the factory, the preparing, spinning, and winding departments, the mechanics' shop, and offices. The dynamo, placed in the engine-room, is a compound-wound "Manchester," capable of developing a current of 180 amperes at 105 volts, and also of supplying 300 incandescent lamps of 16 c.p. each. The dynamo is driven by the main factory engine, power being transmitted from the main shafting to a pulley in the engine-room. A switchboard is fitted up in the engine-room. In the factory about 160 lamps are fitted up, one light being provided for each loom. The lamps are suspended by flexible wire ropes from the wooden casings, and are hung about 2½ft. above the centre of the looms. Each lamp is provided with a reflector, the whole of the illuminating power being thus concentrated on the loom. Judging from the results of the test a single lamp appeared to give sufficient light for each loom, and the shadows were considerably less than gas light. Two lamps are sufficient for the effective lighting of each pass in the spinning department. In the mechanics' shop ingeniously contrived hand-lamps are provided for the use of the workmen. Wall sockets are fixed at intervals along the benches, so that the workmen can have lamps which can be either hung up, or placed upon the bench at the spot most convenient for him. The trial was witnessed by a number of leading manufacturers and gentlemen belonging to Arbroath.

Lithanode.—The use of the lithanode cells invented by Mr. Desmond FitzGerald is, we are glad to be able to record, coming into practical usefulness. Lithanode is not "compressed peroxide of lead," as is sometimes supposed; for, however strongly this material may be compressed, the resulting plate will disintegrate when immersed in water. It is produced from protoxide of lead, or litharge made into a pasty mass with a solution which causes the material to set so that it will no longer fall to pieces in a fluid; the moulded mass is then converted into peroxide of lead in an electrolytic bath. By the use of lithanode, a peroxide plate which is not subject to local action may be constructed; an inoxidisable metal, such as platinum or gold, being in this case used for establishing contact with the plate. A great advantage is thus secured in the construction of an element which will retain its charge for any length of time, even when partly discharged and left immersed in dilute sulphuric acid. In discharging a battery containing lithanode elements it is not advisable to allow these elements to run down beyond the point at which the potential difference between them and a spongy lead element is 1·8 volt—*i.e.*, beyond the point at which the normal E.M.F. of an ordinary lead accumulator has fallen 10 per cent. The electrical capacity of lithanode, when used with the precautions indicated, is almost exactly one ampere-hour per ounce avoirdupois, so that with an element weighing 1lb. 16 ampere-hours may be obtained. It is interesting to note, however, that when the rate of discharge is very high the apparent capacity of the lithanode becomes diminished, the current ultimately falls by reason of polarisations, and the elements require rest before the discharge can be completed to the extent of the full capacity of the lithanode. The rate of discharge obtainable with lithanode batteries varies within wide limits, according to the character of the lithanode, whether dense or porous, the perfection of the contact, the strength of the acid electrolyte, etc. An ordinary rate of discharge, it is stated by the makers, per square inch of lithanode plate $\frac{1}{8}$in. thick, is $\frac{1}{14}$ of an ampere, but in some cases the rate exceeds $\frac{1}{5}$ of an ampere.

Bradford Electric Tramways.—With the view of obtaining a good basis of calculation as to the advisability of the adoption of the overhead electrical system for the Wakefield-road tramway, the Tramways and Baths Committee of the Bradford Corporation have been making arrangements for an experiment with overhead conductors. The arrangements, according to the Bradford paper, for this test are now completed, and will be submitted to the Town Council in the minutes of the committee at the next Council meeting. Mr. Holroyd Smith, the well-known electrical tramway engineer, has undertaken to run an electric car on the tram lines from the Midland Station to the Bradford Grammar School, starting from each end every quarter of an hour, for several weeks, for the purpose of proving the reliability of the system; and he hopes also to prove that the adoption of the system for Wakefield-road would not be too expensive a matter. Mr. Smith will provide the car and execute all the necessary works. The Corporation will supply the electric power, and, by the proposed agreement, if the experiment is not a success, they will not be put to any expense beyond the cost of the supply of the electricity. If it be successful the Corporation will contribute £500 towards the cost of the experiment, and if they proceed to utilise the electrical system for the Wakefield-road tramway, they will appoint Mr. Holroyd Smith as the electrical engineer, giving him a commission of 4 per cent. on the cost of the work falling in his department. The Bradford Tramways and Omnibus Company have granted the use of their lines for the purpose on the condition that they shall provide a conductor for the car and collect and retain the penny which it is proposed to charge each traveller. The car will carry 36 passengers, half of them inside and half outside. Further information as to the working of tramcars by this system is to be obtained by the chairman of the committee and the borough surveyor, who will shortly go to Frankfort, a town in which the conditions as to levels are pretty similar to those in Bradford, to investigate the results of the working of electric tramways there.

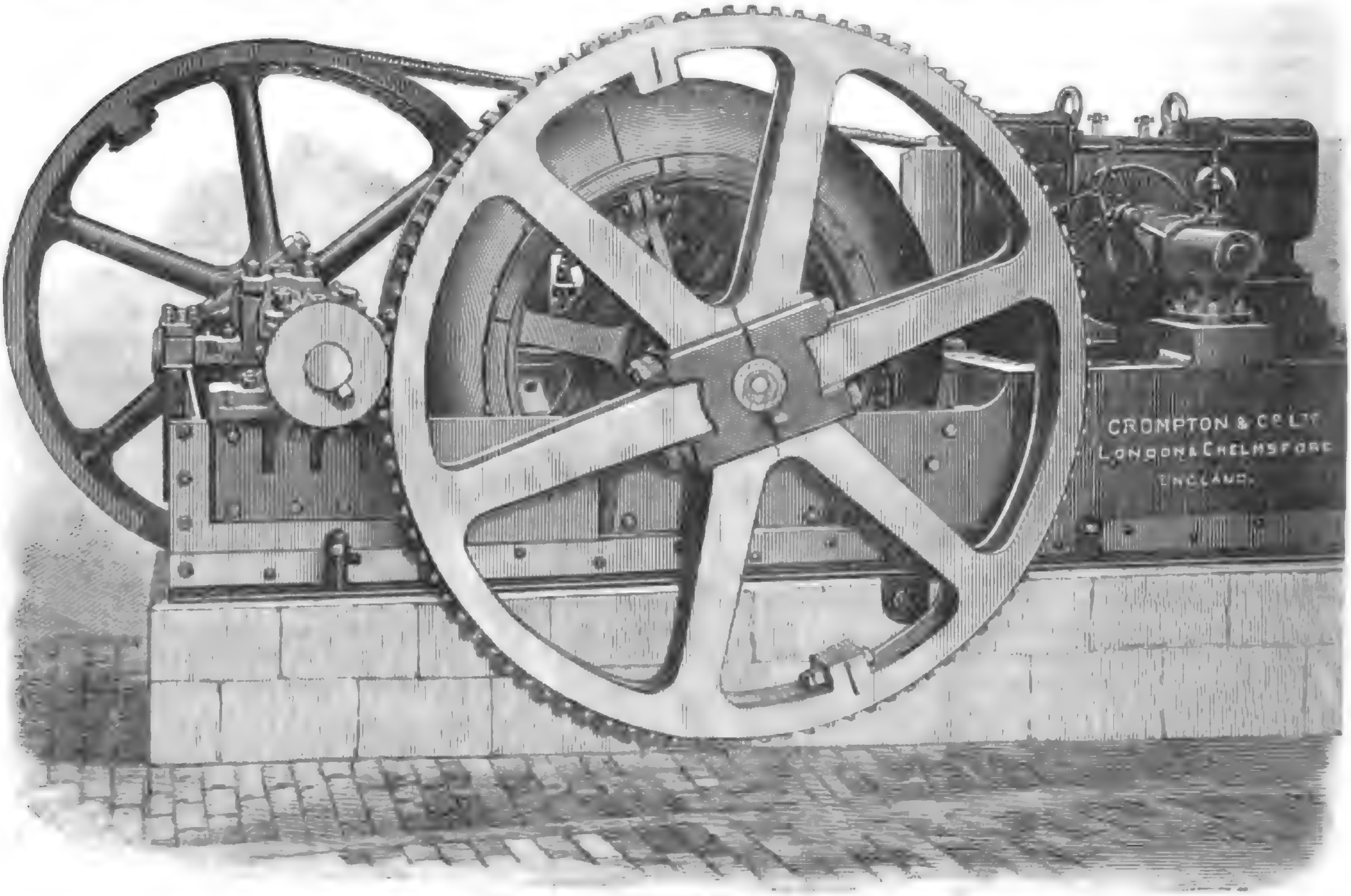
CROMPTON'S ELECTRICAL HAULAGE PLANT.

Mining engineers are beginning to appreciate the immense advantages offered by electrical transmission. For some time past experiments on a small scale have been carried out in different mines, and sufficient information has been obtained to warrant the introduction of a much larger plant, and the haulage machinery recently installed at Abercanaid Colliery for the Hill's Plymouth Company in South Wales is the latest development. Mr. J. C. Howell, of Llanelly, Messrs. Crompton's South Wales agent, undertook to supply the owners with haulage machinery which would replace 27 horses, many hauliers, and a number of door-boys, and enable the output to be increased by 100 tons per day.

After careful consideration it was decided to accept the offer, and Messrs. Crompton and Co. at Chelmsford set to work to design the most efficient plant for the purpose named. Many points had to be most carefully considered, and besides the necessity of making the plant very compact, the haulage machine was required to be most easily controlled. The winding gear was the usual form employed in the main and tail-rope system, and this was found to work exceedingly well. The motor is a Crompton patent series-wound machine, built to run at 600 revolutions per minute, and take 80 amperes at 450 volts. At starting, when a heavier current is required, it will take 160 amperes without harm. The motor is placed horizontally at one end of a wrought-iron frame, which forms the bed for the drum and spur-wheel. The drum shaft, which is of steel, is driven from a countershaft by means of spur gearing, and the motor drives the countershaft by means of six 1in. ropes. The haulage engine is fitted with two drums 3ft. 6in. diameter and 1ft. wide, which are controlled, as above stated, by clutch and foot brake. This plant will haul coal from three different parts of the pit, and although these are not far from the motor at the present time, it is expected that coal will have to be dealt with nearly a mile distant. The generating plant comprises a Crompton dynamo, horizontal pattern, built on a wrought-iron bed-plate. It is compound wound, and will give out 160 amperes at 500 volts, running at 550 revolutions. The cable connecting the dynamo with the haulage plant is 3,200 yards long and composed of 37 strand No. 14 high conductivity copper wire, highly insulated with vulcanised bitumen, double taped and served with two layers of jute yarn compounded between each. It is protected by a double sheath of No. 8 steel wire, the first stranding being of 30 wires, and the second 36 wires, laid in reverse directions. The current density is 870 amperes per square inch, and resistance of cable ·3192 ohm, allowing a loss of potential of 51 volts, or 10 per cent.

From the generating plant the cable is carried down the level by the side of the shaft, and between the hauling engines it is fixed on each side of the roadway. In case of "falls" the cable has been constructed so that it can stand a shearing strain of 10 tons per square inch.

A number of visitors were invited by the Hill's Plymouth Company to see the opening ceremony, amongst whom were many connected with collieries in different parts of the country, and many well-known mining engineers. The engineer to the company, Mr. Bailey, stated that his father had put down the first system of rope haulage for mines 30 years ago, and the electric system of haulage now inaugurated would enable the company to increase its output very considerably. The great difficulty in colliery enterprises was the labour cost, and the coal could not be got to the surface unless they had mechanical means of bringing it up long distances. The system of rope haulage by compressed air was very costly, and they were thrown on their beam ends, as it were, when Mr. Howell, of Llanelly, offered to supply this electrical plant. They found that the capital required was only half that of compressed air; while the latter only gave 30 per cent. efficiency, electricity gave 65 per cent., which was a most important improvement. He added that he placed perfect reliance on Mr. Howell's estimates and working, the more especially as since Mr. Howell had erected their electric lighting arrangements at Abercanaid they had never had one hour's stoppage, which spoke well for the machinery and for Messrs. Crompton's work. The machinery must be well made and put up well to act in this manner. He hoped and believed that the electric haulage machinery started that day would prove



Crompton's Electrical Haulage Plant.

the most economising machinery ever brought into South Wales. They found it impossible to go on with horses, and were glad that they had put down an electric haulage plant, and would have great pleasure in showing and explaining it to any others interested in such matters.

Mr. Howell stated that this was the first experiment on so large a scale underground, and although they had no opportunity of making a trial before that day, he found the machinery was in perfect order and answered every expectation. The most important point for colliery owners to consider was the fact that the electric haulage plant cost only one-half that of compressed air machinery. Coal owners had to apply powers at great distances from the source of energy, and for that purpose he looked upon the electrical machinery which had just been erected as a commencement of what would become general in the colliery work of South Wales. They could deliver at the far end 60 or 65 per cent. of the power generated, which was what no other power known could do.

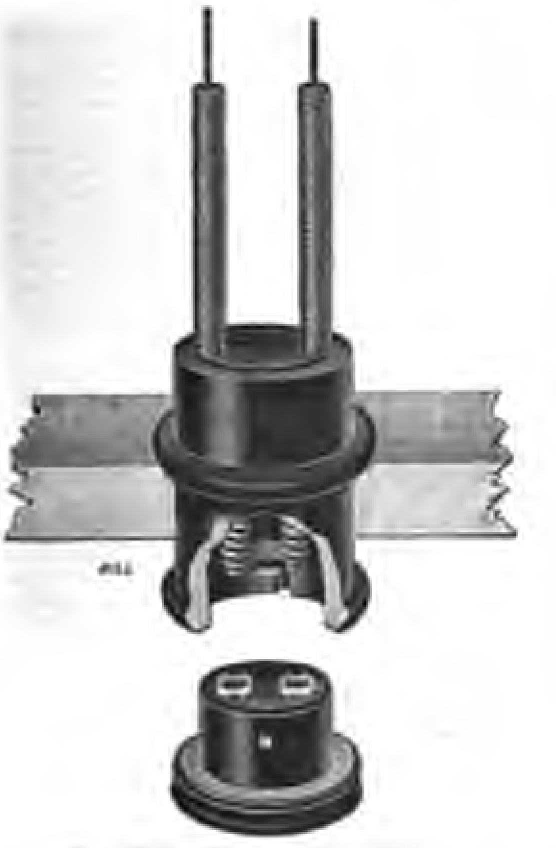
The ceremony was made very interesting by the fact that Mrs. Hankey, the wife of Mr. F. A. Hankey, M.P., managing director of Hill's Plymouth Company, started the steam engine, which put the whole plant in motion. After it had been started, a number of engineers and others interested went down the pit and saw the work done by the haulage engines, of which they spoke in the highest terms.

"Thus started," says the *Merthyr Express*, "the first electrical haulage apparatus in South Wales, the success of which beyond all doubt will lead to its adoption in every important colliery throughout the two countries."

This power installation was referred to by Prof. Silvanus P. Thompson in his lecture on the Use of Electricity for Mining Purposes, delivered at Cardiff on the 26th ult., and was also visited by several members of the British Association, to whom the details of the plant were explained by Mr. Howell.

NEW VITRITE CHEMICAL LAMPHOLDER.

We illustrate herewith a new lampholder, which has been specially designed for use in chemical works, starch factories, underground tunnels, and all places where sulphurous and other fumes are present. These fumes, it is well known, rapidly destroy metal fittings, and engineers who have had much experience with electric light installations in these impure atmospheres have not found reason to be perfectly satisfied with any of the numerous types of holders which have hitherto been introduced for use under these conditions.



New Vitrite Chemical Lampholder.

The Vitrite Chemical Holder, as the new holder is termed, entirely protects the metal lamp connections from any contact with the outer atmosphere. A special form of "Vitrite" cap is supplied with the holder, which is sent to the lamp manufacturer, when ordering, for affixing to the lamp. A small rubber ring is placed on the cap, which then fits tightly into the holder; the rubber washer rendering the joint air-tight. The connection to the spring of the holder is made in the material of the holder itself, and the piece of the insulated wire attached to the holder affords opportunity for making a proper insulated joint with the permanent connections of the installations. The arrangement of the spring in the interior is exactly similar to that in the ordinary form of vitrite holder. A rim is arranged round the top of the holder to allow of it being supported, if desired, by resting in a hole bored in a piece of wood or other fixture. The holders are being introduced by Messrs. Woodhouse and Rawson United, Limited, who have stocked a large quantity of various types for all requirements.

THE WEYMERSCH BATTERY.

There has always been a demand for a good primary battery for lighting a small number of lamps, say, up to 20, and we suppose there always will be this demand, notwithstanding central stations or gas and petroleum engines. No one with central station mains at his door would think of putting in his own gas or oil engine, far less his battery (unless he were an enthusiastic amateur), but many persons residing in country districts, whose mansions are far away from distributing mains, would and do deliberate between engine and battery, and a secret hankering for something less obtrusive in noise and smell than an engine is constantly manifested by owners of country houses. When the houses are large and the lamps numerous, only an ignorant or prejudiced person would hesitate to decide for an engine, which might be arranged at some little distance from the town. But when wants—and incomes—are more moderate, a battery in an outhouse would often be the best solution, if a constant, dependable, and fairly cheap arrangement could be procured.

We have several times during the last year or two described or alluded to the Weymersch primary battery, which is being introduced by the Weymersch Battery Syndicate, of Victoria-masions, Westminster. This battery, which has been favourably reported on by experts, is very conveniently arranged for simple attention. Several improvements in detail have been recently introduced, and during last and this week an exhibition of the battery, in conjunction with a set of accumulators erected exactly as for a moderate house installation, has been on view, and has been examined with great interest by numerous visitors.

The primary battery is used to charge two sets of E.P.S. accumulators, and the current is withdrawn from the accumulators in series for lighting or for driving motors. The primary battery consists of 12 cells, two boxes of six cells each of the Weymersch battery. The carbons, two in each cell, are placed in two porous pots, side by side, in strong depolarising solution, and the zincs, large thin plates, are hung outside in a weak acid solution—half-pint acid to one gallon of water. The solution can be drawn off by taps and syphons for recharging. The battery gives a steady current of 20 amperes at 20 volts for 20 hours, the cost being given by the syndicate as just over a shilling per unit. The battery is arranged to charge two sets of E.P.S. accumulators, 16 in all, which are charged eight at a time at 20 amperes. These can be charged alternately, and discharged when required in series at 30 volts, at 10 or 15 or 20 amperes. The installation is shown lighting a dozen or so 30-volt 8-c.p. incandescent lamps. A large Bernstein lamp of 100 c.p. is also arranged to be switched on to current from the same secondary battery. This interesting installation is completed by the demonstration of its application to motive power. From the same source is driven a Blackman electric ventilating fan, which, by the way, has an interesting motor in the shape of 12 magnets, with the armatures in a ring, forming the rim of the fan itself. A rotary pump taking 60 watts is also driven by a small Crocker-Wheeler motor and worm gearing. Small six-cell batteries are also shown driving electric motor for sewing machines. As regards cost, the large primary battery costs complete about £16, and the whole electric light installation, with the exception of artistic fittings, would be almost exactly £100. The first cost is thus within reach of country householders. It may be interesting to add that besides the installation at Victoria-mansions, there is a similar one in a private house at Staines with a set of accumulators supplying 12 30-volt 8-c.p. lamps, and others at Eastbourne and Horsted (Sussex), while a primary battery installation erected some time back in Park-lane, St. James's, has recently been fitted with sets of accumulators with satisfactory results. Messrs. Merryweather are exhibiting a pump driven by the Weymersch batteries, and Messrs. Blackman keep one of their electric ventilating fans in motion at their City offices by the same means.

ON AN ELECTRICAL PARCEL EXCHANGE SYSTEM.*

BY A. R. BENNETT, M.I.E.E.

The congested state of the streets in many of the large towns—notably in the City of London—invites reflection as to whether it is not to possible to devise means by which vehicular traffic may, to a certain extent, be diminished. To avoid absolute blocking of the thoroughfares it is now necessary to forbid the collection or delivery of goods in certain localities during business hours, and trade suffers under such restrictions, while warehouses have to be of larger capacity than would be needed were the free receipt and despatch of goods permissible.

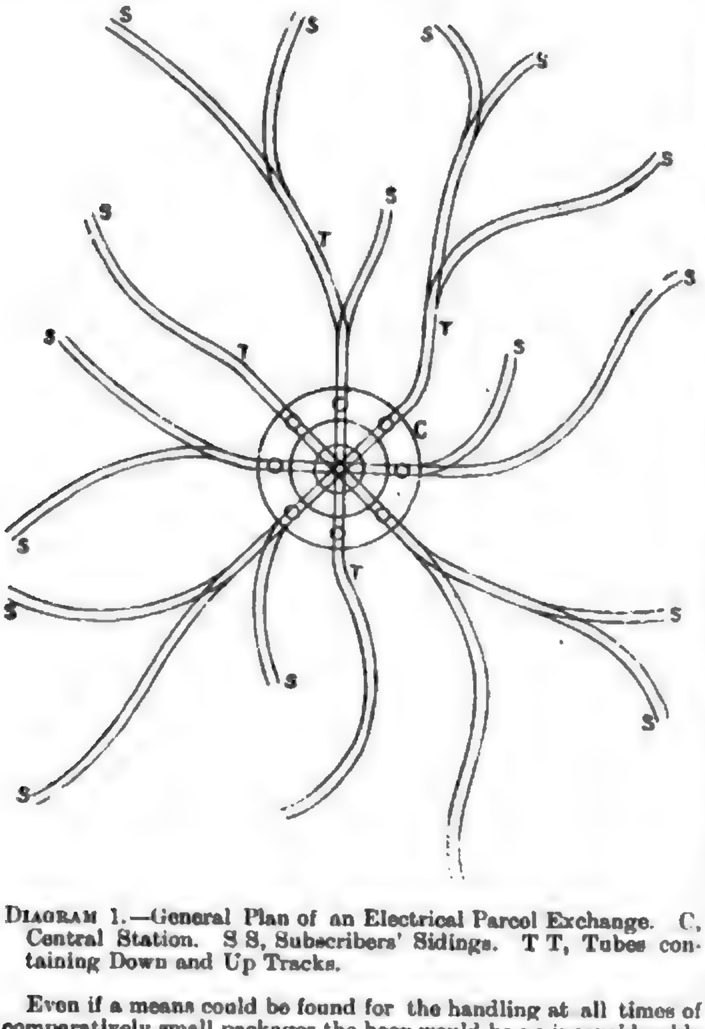


DIAGRAM 1.—General Plan of an Electrical Parcel Exchange. C, Central Station. S S, Subscribers' Sidings. T T, Tubes containing Down and Up Tracks.

Even if a means could be found for the handling at all times of comparatively small packages the boon would be no inconsiderable one; and with the view of breaking ground in this direction I have worked out a scheme, founded on the telephone exchange idea, whereby parcels can be freely interchanged between any number of buildings, no matter how widely apart they may be situated.

I propose to effect this by means of a number of miniature electric railways, radiating from a central station, and having branches or sidings into all the buildings to be served. The general plan of such a system is shown by Diagram 1.

The railways would be laid in tubes of a rectangular section, and so arranged that the down track would occupy the lower, and the up track the upper, portion of the tube. To permit of examination and repairs, the tube should be large enough to allow of a man or boy creeping through, and in order to afford space for this the rails are laid, not on cross sleepers, but on brackets fastened to the walls of the tube. During idle hours the full height of the tube would thus be available for the passage of workmen. This arrangement is shown in Diagram 2. In order to render the rails useful as conductors they are insulated.

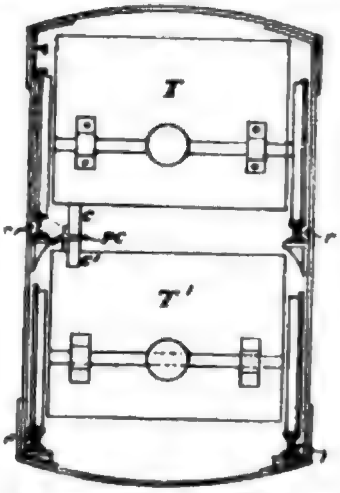


DIAGRAM 2.—End Section of Tube. T T^1, Trains. c c^1, Collectors. r, Rails. P C, Parallel Conductor.

On the rails would run trucks propelled by electromotors deriving their current either from one of the rails or from a separate parallel conductor. On the down journey a truck would gather current by a collector pressing on the under, and on the up journey by one pressing against the upper surface of this conductor, separate collectors being provided and connected to the motor in such a way that a truck could not be made to travel in the wrong direction. If on the down track, it could only obtain current through its upper collector, which would propel it always away from the central; if on the up track, its lower collector would only be operative, and this would always move it towards the central. There are several ways of attaining this end. Collisions between meeting trucks would consequently be impossible. A side section of the tube, showing passing trains, is shown in Diagram 3.

The tubes may be of any size, but I have taken 2ft. wide by 3ft. high as a suitable one. This would permit of trucks 20in. wide by 14in. deep being used. Their length might be considerable, but it would be regulated by the radius of the curves. Supposing 48in. were found practicable, such a truck would contain 13,440 cubic inches, and so be available for pretty large packages. In order to obtain a deep, unbroken box, it is necessary to place the wheels at the ends; and, to get as flexible a wheel base as possible, the wheels should have side play. The electromotor is mounted on a separate carriage, and coupled to the truck, as shown in Diagram 4. Only one end of a truck is supported on wheels, the other resting on the motor-carriage by means of a pin which drops into an eye. Each truck would be fitted with such an eye, so that when a train consists of more than one truck, the coupling-pin of each supplementary truck will drop into the eye of the next. If the wheels are given side play, a very flexible train, like that shown in the diagram, capable of traversing short curves, would result. To prevent bearing down when heavily laden, each truck may be fitted at its coupling-pin end with a pair of unflanged wheels or rollers that will rest on the rails without increasing the rigid wheel base. To secure the adhesion necessary for steep gradients, the wheels of the motor may be coupled, or each pair driven by a separate belt from the motor pulleys.

The central station would be established in a suitable locality. In a large town there might be several stations, connected with each other by one or more sets of tracks, just as telephonic switch-rooms are connected by junction wires. The central station would contain the engines and dynamos for generating the electricity required for working the system, and it might also be utilised as an electric light generating station, or a telephone exchange, since the tubes laid for the parcel exchange service would serve admirably for containing and distributing conductors and wires.

At the central station a turntable or other device for the interchange of trains between the tubes would be provided for each tube. These turntables would communicate with each other, either direct or by means of a central turntable, so that a free interchange of trains between the tubes would be secured. Each tube and turntable would be worked by an operator. The turntables would be in two stages to accommodate the down and up tracks, between which traffic would be exchanged by altering the level of the tables by means of hydraulic jacks. Diagram 5 gives a general idea of such a system. Empty or lying trucks would be stored in siding tracks built one above the other, and reached by altering the level of the turntables.

Connection with the premises of subscribers to the system would be made by short spurs or sidings diverging from the nearest main tube. At the junction of the branches with the main tracks switches similar to ordinary railway switches would be placed, and controlled by the operator at the central by means of electro-magnets. These switches may be arranged in various ways. They may be kept in position for through main-line traffic by means of springs or permanent magnets, and be shifted to connect with the sidings by a current sent from the central, resuming their normal

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* Paper read before the British Association.

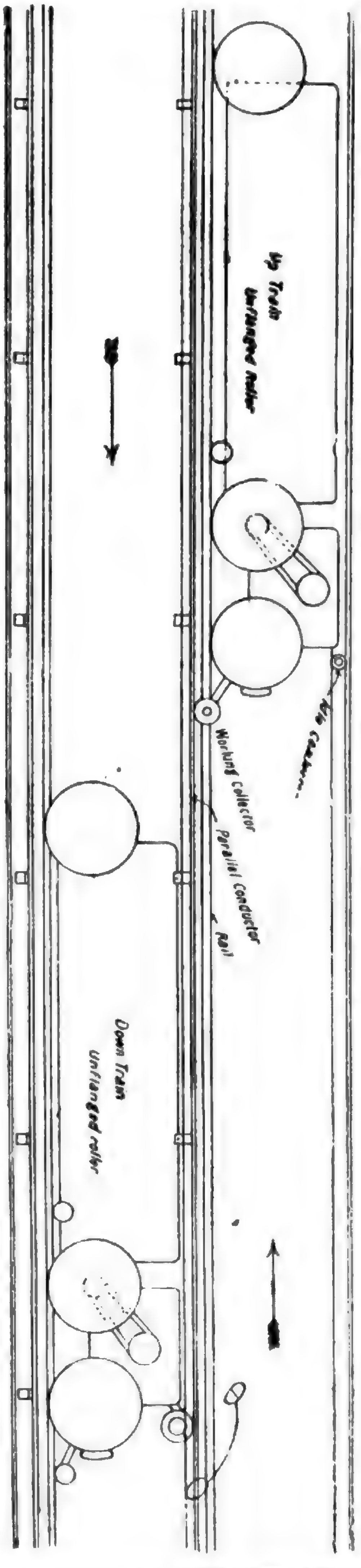
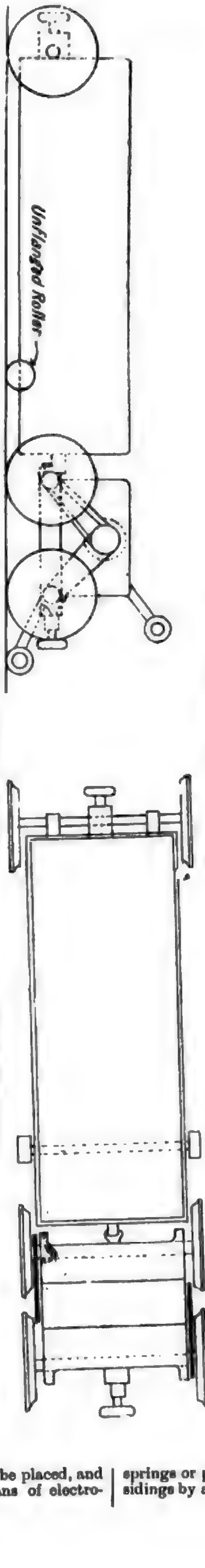

Up Train
Unflanged Roller
Working Collector
Parallel Conductor
Rail
Down Train
Unflanged roller

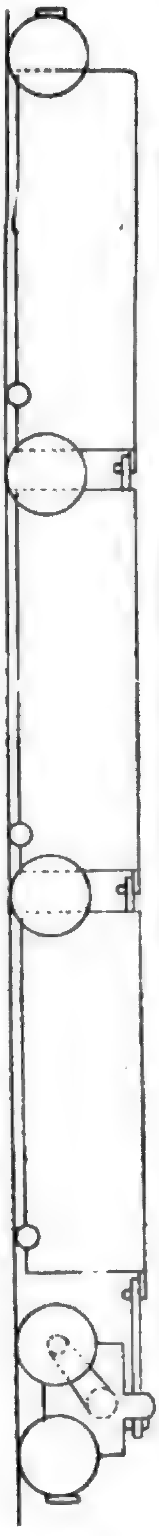
DIAGRAM 3.—Side Section of Tube of Electric Parcel Exchange.


Unflanged Roller

Elevation.

Plan (looking down).

DIAGRAM 4.—Motor and Truck.



Elevation of Train with Three Trucks.

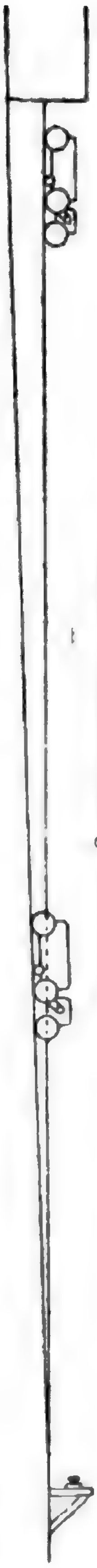


DIAGRAM 7.—Subscriber's Siding. Side View.

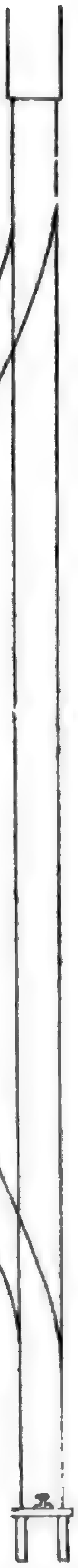


DIAGRAM 8.—Subscriber's Siding. Plan.

position as soon as the current ceases; or they may be wrought entirely by electricity, a current of one sign shifting, and one of the opposite sign replacing them.

The operator will, of course, require to find and work any switch with certainty and rapidity. I propose to enable him to do so by the arrangement shown in Diagram 6, although several other methods, requiring fewer conductors, could be devised. One pole of a battery or dynamo is joined permanently to an outgoing conductor, which traverses the whole length of the tube. At each switch a branch is taken from this conductor, which, after passing through the electromagnet controlling the switch, returns to the central, and is there taken through an electromagnetic indicator, which may resemble a railway semaphore signal in appearance, and a contact-maker, to the other pole of the battery. By closing any of the contact-makers, the operator can put over any of the siding switches, and the indicators show him that the current is passing. In the diagram one switch is shown over and the semaphore indicating a clear road for that siding. It might be arranged to show him not only that the current is passing through the coils of the electromagnet, but that the armature has actually been deflected and the switch put over.

The sidings into subscribers' buildings consist of down and up tracks one above the other, but when space is available these are caused to diverge after entering the building, and ultimately to meet in one track, so that trains may be shifted from the down to the up track without lifting them off the rails. Diagram 7 illustrates my meaning.

The parallel conductor on the down track need not be carried into the subscriber's building, but may be stopped short within the tube, and the train allowed to finish its journey by the momentum it has acquired. If the conductor were continued to the end of the track there would be waste of energy and danger to the motor in the event of delay in attending to a truck on its arrival.

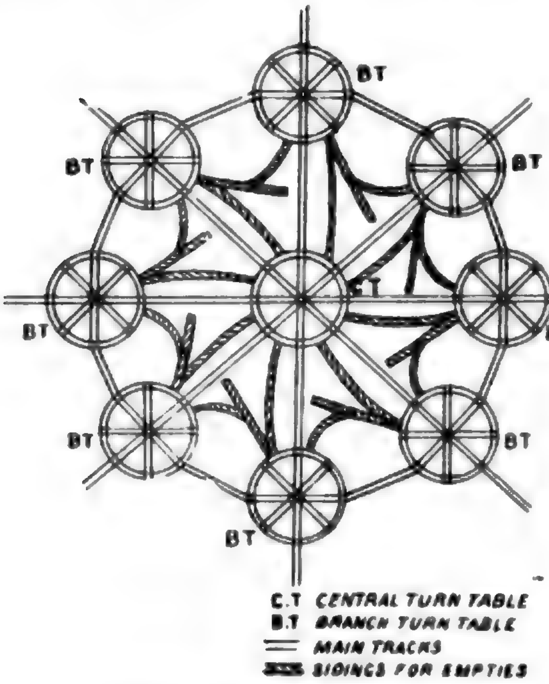


Diagram 5.—Plan o Turntables.

On entering a subscriber's building, a train would have its speed reduced, and finally be brought up by the axle engaging with a hook attached to a weight or spring, or a projection on the truck could depress triggers, which would rise again after its passage and prevent any running back due to rebound or gravity. Such triggers could be electrical contacts, and be made to signal a train's arrival to any part of the subscriber's premises and to the central station. Similar stopping devices would be necessary at the central station to prevent arriving trains over-running the turntables. The subscriber's siding would terminate in an elastic buffer, or stop-block, which would finally bring the train to a stand.

After leaving the main line, and getting well into the siding, a train could be made to break the circuit of the return conductor operating the switch by passing over one or more trigger contacts. The semaphore arm at the central would thereupon rise temporarily and ring a bell, notifying the operator that the train was safe in the siding, and that he might clear the switch for other traffic. Such triggers, if made workable in the down direction only, could be arranged to prevent a train running back and fouling the main line. Such trigger contacts are indicated at T in Diagram 6.

In order to keep traffic circulating, it is necessary that the operator shall be able to follow the progress of all the trains in motion in his tube, so that the position of each and of any accidental stoppage may be known. This may be accomplished much in the same way as that proposed for operating the switches. One rail of a track is in continuous electrical contact throughout. The other is divided into insulated sections of any desired length. If a battery is permanently connected to the continuous rail, and the sections joined to its opposite pole by means of return wires, in the circuit of which electromagnetic semaphores or other indicators are included, the progress of a train will be traceable throughout its whole journey, for, as it short-circuits the rails, the semaphore arms will successively rise to "danger" as it passes from section to section and fall to "line clear" behind it. The failure of a train to enter any siding will be revealed, as its presence on the section beyond will immediately be apparent. The plan is illustrated by Diagram 8.

Should a train, through any accident short of disrailing, stop in the tube, the semaphore of the section it is on will remain continuously at danger, and the operator will know that such a stoppage has taken place, together with its position, and take steps to remove it. For instance, he could send an empty truck forward, the speed of which could be reduced to a minimum as it approaches the disabled train by modifying the amount of the propelling current, until it strikes against the disabled vehicle; then, full current being turned on, both trucks could be forwarded to the consignee or shunted at the next convenient siding. The owner of that siding could be requested by telephone, if so connected, or, otherwise, by a note placed in the empty truck, to couple the vehicles together and return them to the central on the up track. A stoppage on the up track would be dealt with by bringing a truck out of a siding lying beyond and causing it to push the disabled one into the central.

Having explained how the down-line switches are managed by the operator, I shall next describe how he can be given control of the up-line ones, too, as it would never do to allow subscribers to send trains into the tube at will.

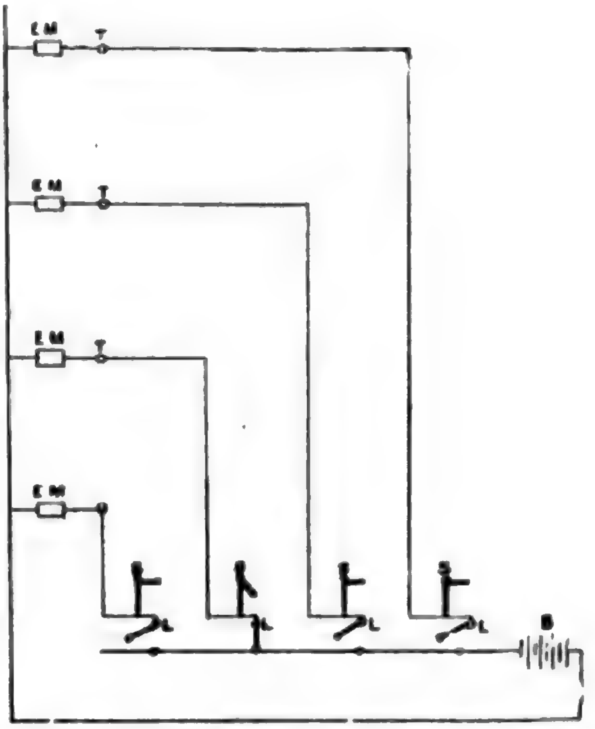


Diagram 6.—Electrical Control of Subscribers' Sidings (Down). B, Battery. E M, Electromagnets Controlling Switches. S, Indicators. L, Circuit Closers. T, Contact Breakers.

A branch from the parallel conductor carrying the propelling current is taken into the subscriber's premises on the up track for a short distance, so as to permit of the collector of at least one truck being placed against it, but the portion so taken in is not in permanent electrical connection with the main portion of the conductor, but is effectively insulated from it until the operator at the central station is ready to admit the train to the main line. At the entrance of the tube the up track is obstructed by a projection from the armature of an electromagnet, the projection being of sufficient solidity to resist any attempt to push the train past it. The electromagnet is in circuit with a conductor forming part of a system resembling that which controls the switches on the down line. By using reversed currents the same set of conductors might be made to operate the down-siding switches, and these up controlling electromagnets; in any case, the same outgoing conductor would serve for both purposes. The armature of the electromagnet, when attracted by a current from the central station, removes the obstructing projection, and completes a connection between the main parallel conductor and the portion, hitherto insulated, within the subscriber's premises. If the collector of a truck is pressing against the conductor when this takes place the motor at once obtains current and enters the tube. The up siding joins the up main line by a switch, which, like catch-points on a railway, is opened by the wheels of the truck itself, so that after the operator has started a train no further control is necessary until it reaches the central. As soon as the train reaches the main line it begins to operate the up semaphores at the central, and the operator again blocks the siding.

When starting a down-line train, the operator at the central places the train at the entrance of the tube so that the collector of at least one of the motors presses against an insulated section of the propelling-current conductor. If the consignee is connected by telephone or electric bell, the departure of a load for him is duly signalled, and as soon as the down line is sufficiently clear of previously-despatched trains, as indicated by the semaphores, the operator admits current to the insulated section of the conductor, and the train enters the tube. The switch of the siding it is intended for being set, the trains turns into it and signals the fact to the central by breaking contact at T, Diagram 6. The operator thereupon takes off the current, and the switch resumes its normal position. The train runs into the subscriber's premises, where it is gradually brought up, and where it announces its arrival by ringing bells, or otherwise. The load is taken off, the train transferred to the up track, and when it is desired to return it to the central, either with a new lading, or empty, it is placed at the entrance of the tube with the collector against the insulated section of the up propelling-current conductor. The operator is advised by signal that a train is ready for despatch. When he has a clear line he works the electromagnet, which removes the mechanical obstruction, and at the same time gives the motor current, and the train runs up to the central, where its motion is gradually arrested. If the load is consigned to the central, the operator turns the truck or train into the siding assigned for such traffic; if addressed to another subscriber, he transfers it to the down track of his own tube, if the consignee's siding is served by it; if not, he forwards it by means of his turntable to the operator who works the tube it is destined for. So, when one subscriber sends a parcel to another, he despatches it, in the first instance, to the central station, where the operator re-forwards it as required.

Should a truck by mistake be delivered to the wrong siding, the subscriber has only to transfer it to the up track and return it to the central.

Although each subscriber could advantageously be connected, telephonically or telegraphically, with the central, such a means of communication is by no means necessary. Trains, as already stated, would announce their own arrival in the subscribers' premises, and if subscribers would place trains on the up line ready for departure, the operator could withdraw them when convenient without troubling the subscribers further. It would be easy to make a rule for the operators to tap all or particular sidings at prescribed intervals during the day, and so withdraw unannounced traffic. The subscribers could be supplied with empties during the night or slack hours of the day without any attendance on their part. Automatic working could be carried further still, for it would not be difficult to arrange to unload trucks sent into subscriber's buildings, and afterwards withdraw them as empties, without any personal attention. The loads could be tilted off, and the truck, when clear of the down-propelling current, run down an incline and through cross-over points to the up track, where it would find the up-propelling current, and immediately commence its return journey to the central. Thus, a man's coal cellar might be filled in the night by a succession of such automatic trucks.

If desired, the starting levers at the central could be interlocked with the levers controlling the siding switches, so that a following train could not leave until the switch set for the preceding one had been restored to its normal position. Collisions between following trains could be prevented by an automatic block, such as was devised by Jenkin and Elliott and Ayrton and Perry for telpherways, by which the second train loses its propelling current if it approaches the preceding one too closely. These precautions would, however, tend to restrict the capacity for traffic, and, as collisions would not endanger life, I am inclined to think that strongly-built trucks, with good elastic buffers, and perhaps extra deep flanges to the wheels to prevent disrailing, would constitute sufficient safeguards against damage to goods arising from an occasional collision. The operators would not allow two trains on the same section simultaneously, and if the sections are 100 yards in length, I contemplate the possibility of a pair of skilful operators, one for the down, the other for the up track, keeping 34 trains circulating in a tube a mile in length—17 down and 17 up. The various control movements are but momentary, and they would only have to be timed in accordance with the indications of the semaphores. At eight miles an hour, 17 sections to the mile would give nearly half a minute between each train.

The body of the tube, if of metal, could constitute the return for the propelling current. For signalling the progress of trains, one rail of each track might form the outgoing conductor, while the returns could consist of small wires—No. 18 gauge would be ample—made up into cables. One outgoing conductor of No. 12 gauge could carry all the current for operating the siding switches and block electromagnets, the returns being No. 18's cabled. The number of conductors would dwindle as the distance from the central increased, and as they would be small and cheap, the outlay for them would not be considerable. Of course, the various switches and semaphores might also be worked off the parallel conductor supplying the motors, as shown in Diagram 3.

For inspection and repairs a special form of truck or platform, on which a man could crouch or lie, would be provided. The motors of these whould be under the control of the men using them, and they would be fitted with brakes, incandescent lamps, and telephones for communicating with the central.

Although the proposal for a system of this nature may appear a little startling, its details, as I have sketched them, comprise no device that has not been thoroughly tested in the telegraph and signalling departments of the Post Office and railway companies, or in connection with electric traction. Mr. Preece, many years ago, employed electromagnetic semaphores such as I propose. The shifting of switches and blocking by electromagnets has been rendered familiar by the labours of Spagnoletti, while the picking up of current has often been demonstrated, notably on the City and Southwark Electric Railway. It may, consequently, be confidently asserted that the plan would work, and work well.

Whether such a system would pay is another matter. If constructed specially and solely for parcel work, probably it would not, although the surprising developments of the last decade scarcely justify us in assigning limits to the possible developments of the next; but I assume that the construction of subways beneath all the chief thoroughfares of large towns, for the purpose of containing electric light and power leads; telephone wires; pipes for gas; water, fresh and salt; hydraulic and pneumatic tubes; and, perhaps, oxygen or ozone to supply our homes with mountain air, together with other possible adjuncts of our complex civilisation, will shortly become an absolute necessity. A beginning in that direction has already been made by limited companies in some of the American towns, and we must sooner or later follow suit. Then, when that time arrives, an electrical parcel exchange could be carried out economically and effectively as part of the scheme. I look forward to a time when our footpaths and carriageways will be laid upon the lids of huge boxes, through which, perhaps, in addition to the various fittings already named, will be carried well-lighted footways, affording crossings and short cuts for passengers at congested spots.

Supposing, for the sake of argument, that the scheme is financially practicable, its many uses will, I think, be readily admitted. What an aid it would be, for instance, to the postal service were St. Martin's-le-Grand connected by such tubes with the principal post offices in the City and West-end. The telegraphic department at present derives great assistance from pneumatic tubes, an inch or so in diameter, through which crumpled-up telegrams are forced in indiarubber balls. If letter and parcels could be interchanged in a similar manner, deliveries could be both expedited and multiplied, and the capacity of the department generally increased. Parcel-post hampers could be despatched to, and received from, the great railway stations in a minute or two, and the mails of subscribers to the exchange system could be delivered without the aid of postmen, while such subscribers would be able to despatch letters and parcels, together with telegrams and the money to pay the charges thereon, straight to the chief post office, so saving labour and delay at the branches. Such a system would form the first step towards telegraphing, or rather wiring, matter.

Apart from the post office, many uses suggest themselves. Parcel receiving offices and great despatchers of small packages, like the Co-operative Stores, Whiteley, and others, would find direct connection to the railway stations, and with other business houses, an important boon. Buyers could telephone for samples and patterns of all kinds and obtain them almost immediately. Hotels and restaurants could telephone for, and receive, in a few minutes supplies they may run short of, and enable their customers to choose wine, not only from the cellars of the establishment, but from those of every wine merchant on the system. Cooks at private houses could not only telephone for a leg of mutton, but have it ringing a bell in the course of a minute or two to announce its arrival. The story of the doctor prescribing by telephone for a baby whose cough he had listened to by the same means is well known. A friend of mine suggests that, with the parcel exchange system, the mother could improve on that by sending the baby bodily to the doctor, *via* the central station, and receiving it back with a bottle of medicine in its fist and a mustard-leaf on its chest.

Discussion.

Sir Frederick Bramwell said the author had very well thought out the difficulties attendant on such a system as was proposed, and, so far as he could see, he had overcome them all. The only question was, would it pay? He had had some experience in tunnelling, and he believed the tube or tunnel could not be made for less than £13 to £20 per lineal yard. For his own part, he should be very glad if such a scheme could be brought into operation.

Mr. Binnie said this tunnel would take up at least 4ft. by 2ft. under the roadway, and, therefore, in order to introduce this system it would be necessary to shift the whole of the existing mains. The difficulty of making the house connections would also be very great, and he did not see how the work would ever pay as a commercial undertaking. The idea might be worked between the central and branch stations in London, and he had no doubt the Post Office authorities would introduce such a system before long.

Prof. A. C. Elliott thought the only obstacle was that of cost. When the electric light was first introduced, people said it would not be successful because of the cost. In spite of this, however, it had come into fairly general use, and if there was found to be a real necessity for an electric parcels exchange, the difficulty of cost would likewise be overcome.

Mr. Greathead, while admitting the advantages which would be derived from such a system, thought the time was somewhat distant when they could have a complete system of subways such as would be required to bring the scheme into operation.

Mr. Bennett said he had considered this question of subways, and he found that it would be necessary to make a clean sweep of the existing mains and begin over again. The Post Office would soon have to adopt some such system to meet their requirements, and they must be the authorities to initiate the scheme. The parcels post was growing, and a small army of men and mail carts were employed in the transmission of the parcels.

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THE GROWTH OF ELECTRIC LIGHTING.

Quite recently the *Times* had an excellent article to show that the progress of electric lighting in England, and especially in London, was very favourable, even when compared with the progress in the States. One point in the *Times* article seems to have struck some persons as hardly correct. The slow progress after 1882 has usually been attributed to Chamberlain's Act of that year. The *Times* says not so, but to the fact that electrical knowledge was not sufficiently advanced to give what was required. Mr. Massey rather supported the contention of the *Times*, while Mr. Crompton, in a long communication in the issue of last Saturday, waxes somewhat indignant that anyone can imagine the fault to be anywhere but in the Act of Parliament. After all, any discussion upon the point can be of no earthly value. Opinions differ, and many people incline to the view that much may be said for both sides, and that each is partly right and partly wrong. So far as electric lighting is concerned comparisons are odious, and comparison with American progress especially is not worth the paper it is written upon. The conditions existing in the two countries were and are so diametrically different that there might be plenty of incentives to install one artificial light in one place, while there exists quite as strong an incentive to install a different artificial light in another. A town that has no artificial light, or where gas is from 10s. to 20s. per thousand, does not look upon electricity in the same way as when gas is fully installed and costs 2s. 6d. or 3s. 6d. per thousand. It is of little use either to flog a dead horse or to flog a willing horse, and it is of just as little use to attempt to prove that a town in England ought to follow the lead of a town in America, without stating exactly the conditions prevailing at both places.

There is one phase in the history of electric lighting that is never, so far as we know, sufficiently acknowledged by speakers and writers. We have more than once had occasion to ridicule the claims Americans have made for Edison as an inventor, but we are prepared to admit—nay, claim—for Edison, above all men, the position of having first shown that electric lighting on a large scale was practical, and worthy of commercial enterprise. While Englishmen were pottering about—some with this detail and some with that, none, however, troubling about lighting as a whole—Edison was busy working out a complete system, giving due attention to motors, dynamos, mains, and lamps, endeavouring to make every part fit and work smoothly as a whole. It matters not that the dynamos of that time, as compared with the dynamos of the present day, partook somewhat of the nature of leviathans; the New York installation from a central station was a practical success.

A consideration of the work that Edison did in America will go far to prove Mr. Crompton's contention, at any rate, to be partially correct. He says: "I do not think, however, I shall be contradicted when I state that in 1883, the year after passing the Electric Lighting Act of 1882, our knowledge of the subject was sufficient to enable us to design central stations on what is known as the low-pressure system, which, in all important respects, were absolutely identical with those that have been since designed and carried out, on the triumphant success of which your correspondent so ably comments." On the *Times* side of the question we have quite as pertinent facts. Some ten millions of pounds were asked of the public, the greater portion given, and not twopence farthing spent in lasting work, or work that Mr. Crompton would acknowledge as coming under the head of electrical engineering. Surely, the *Times* might argue, if the knowledge was as great as Mr. Crompton says it was, something ought to have been done by somebody. Large installations were promised, but not executed. It was not altogether a question of money, for the money was forthcoming, though the work was not. Would it not be best, therefore, to shut our eyes as far as possible on the past, and look more closely on the present and the future?

The Government and shipbuilders helped to stem the crisis in the demand for ship lighting, Edison on the other side and the Grosvenor Gallery on this side prevented absolute failure, and now a healthier tone prevails. True it is that from time to time a more or less extensive promoting swindle takes place, but at the present time promoters have to provide something for working capital, and not take all the money subscribed as legitimate spoil.

THE LATE MR. L. J. CROSSLEY.

It is with sincere regret we record the death of Mr. Louis J. Crossley, J.P., which occurred at his residence, Moorside, Halifax, on Sunday last. Mr. Crossley's name is a household word in telephonic circles, he having designed that very successful form of transmitter known by his name as the "Crossley Transmitter." Mr. Crossley was the only son of the late Mr. John Crossley, of Manor Heath, Halifax, and was born in 1842. The following extracts from the special edition of the *Halifax Courier* of Monday last gives a full account of the late gentleman's scientific proclivities:

"It is in the wide field of electrical science, however, that Mr. Crossley has made his name most famous. At the age of nineteen years he began to take a keen interest in electricity, at the same time paying some attention to meteorology, for his work in which he was made a fellow of the Royal Meteorological Society. While residing at Willow Hall, one of his earliest inventions, the Crossley anemometer, was brought out. This was a gauge for the purpose of recording the velocity and pressure of the wind. About the same time Mr. Crossley and M. Brequet, a leading French electrician, took out a patent for what is known as the alphabetical telegraph instruments, of which some thousands were sold. He was among the first members elected on the formation of the Society of Telegraph Engineers, and remained a member up to his death. On several occasions he was requested to bring his scientific researches before that society, but with characteristic modesty he always pleaded business engagements as a reason for not complying. His fondness for yachting led him to make frequent visits to Windermere, across which lake, from the Crown Hotel, Bowness, to the Ferry Hotel, he laid a cable. It may here be mentioned that he became well known at Windermere and Bowness, gave lectures there, and was very popular with the boatmen.

"Mr. Crossley was the first to introduce electric lighting into Halifax on a practical scale. This he did by getting down from London the celebrated Gramme machine which had been used for lighting the Victoria Tower in the Houses of Parliament. This machine was specially procured by him, at his own expense, to illustrate one of his lectures on behalf of the Literary and Philosophical Society. On the day of the lecture the machine had not arrived, and a message came that it could not be got away. His reply was terse and characteristic: 'It must be done; get more men; get special truck.' And the machine was sent. No expense or trouble were, indeed, spared in procuring apparatus when once he had undertaken to lecture on any subject in connection with which such apparatus was required. On this occasion he showed how sounds could be conveyed by means of electricity, and exhibited also the electric light from a window overlooking Harrison-road. He was likewise the first in Halifax to adopt the electric light for commercial purposes, Albion Mills and parts of Dean-clough being fitted with it.

"The announcement of Prof. Graham Bell's invention of the telephone took everyone by surprise. Mr. Crossley, always on the alert, secured the first telephone that came to this country and had it fixed to the wires existing at Dean-clough in place of the Crossley-Brequet instruments, which were then in use. As in the case of the other inventions and discoveries, he was early at work lecturing, in Halifax, Brighouse, Huddersfield, and other places, explaining and illustrating this latest development of electrical science. Finding that the telephone lacked that efficiency which was required to make it useful for commercial purposes, Mr. Crossley set himself to improve it, and ultimately brought out and patented the 'Crossley Transmitter,' by means of which the message delivered was more audibly carried to its destination. One remembers well the early stages in this development, how experiments were made in Square Church and other places, and the delight one experienced on a certain Sunday evening when, going over to Bradford, one heard there the sonorous tones of Dr. Mellor announcing the hymns and preaching in his own church, eight miles away; and when, also, the singing of the congregation could be heard with equal distinctness. The invention proved very remunerative. It was so completely satisfactory that the United Telephone Company, Limited, who hold the Bell, Edison, and other leading patents, made overtures to Mr. Crossley, and ultimately gave him £20,000 for his patent."

Mr. Crossley erected one of the best private electrical laboratories in the kingdom, and his death will leave a considerable gap in Northern scientific circles. The funeral took place on Wednesday, and was attended by many friends of the family, who deeply sympathise with them in their great loss.

GERMAN MUNICIPALITIES AND ELECTRICITY.

At home we find when municipal authorities are desirous of starting a central electric light station of their own, or of undertaking similar work, that deputations are sent here and there in a haphazard fashion to make inspections. The result often is that the deputations return home with their minds in a state of chaos, owing partly to inability to understand what they have seen, and partly to the contradictory nature of the information imparted by the representatives of rival systems, whilst it may also happen that the system most suited to local requirements has not been inspected. The authorities at Frankfort-on-the-Maine have, however, inaugurated an entirely novel course, which merits imitation hereafter. They invited representatives from the whole of the municipalities in Germany to hold a "Städtetag" at the Frankfort Electrical Exhibition, the object being not for these gentlemen to talk, but to receive information as to the present condition of the electrical industries, and to see for themselves what can really be done. The invitation has been heartily responded to by several hundred gentlemen, and the proceedings commenced on the 27th, and were concluded on the 29th August.

With a view to prepare the minds of the municipal deputations for the subject to be treated, Herr Uppenborn compiled a *brochure* of 271 pages, profusely illustrated, under the title of "The Supply of Towns with Electric Current." This enabled the members of the meeting to take a rapid glance at the various systems available, and also gave them an idea of what they would see at the exhibition itself.

The Mayor of Frankfort presided at the meeting, and stated that they had felt desirous of letting their colleagues in municipal affairs see what progress had been made in electricity. The first paper read was by Herr Uppenborn, who dealt with continuous, alternating, and rotary current dynamos, accumulators, arc and glow lamps, electromotors, etc., putting the information which he gave in a popular way, as pure technicalities would not have been readily grasped by his hearers. He also described what was to be found in the exhibition.

In order that practical demonstration might be made of the statements contained in the paper, an inspection was made of exhibits, the meeting being conveniently held in the Victoria Theatre of the exhibition. Herr O. von Miller, the technical manager of the exhibition, acted as *cicerone*.

In the afternoon Herr Andreas Meyer, chief engineer, Hamburg, raised a discussion on the proposed legislation relating to telegraphy and electric installations, in which he dealt both with the general and the technical features of the position. He stated that the ground occupied by streets was the property of the towns, but that in the past the surface had been mainly used, while now the use of the underground portion was more and more required. It was, consequently, necessary to look into the question of subways for the various systems, apart from gas and sewers. The postal authorities in this matter claimed a prior right, and objected to other conductors because of the disturbance of the weak telegraph current by others more powerful. It was rather a pity that Steinheil had discovered the earth return, as if he had not the Post Office would have had return wires, and would not have raised difficulties as regarded electric supply companies. As matters stood, the Post Office was in a position to make itself independent of powerful currents, and should do so. Mayor Becker, of Cologne, who went further into the same question, was of opinion that the laws on the subject were inconsistent.

A banquet followed, and in the latter part of the evening various amusements were attended by the various members of the meeting. On August 28 the proceedings began with a paper by Herr Oskar von Miller on "The Different Systems of Distributing Current for Lighting and Power Purposes in Towns." By means of diagrams, experiments, and the use of non technical language, he imparted much valuable information to his hearers. As regarded the best system of distribution, he said there was no "best system"; it could not be said that one, and one only, should be employed. Local conditions had generally to be considered. To the consumer it did not matter whether he was supplied with continuous or alternating current. The special advantages and disadvantages of one system more or less counterbalanced those of others. The development of all was, however, such that electricity was not now merely a commodity for great cities, but also for small villages, for industrial purposes as well as for use as a luxury. Herr Ross, of the Helios Company, pointed out that the supply of a town with electricity was not so much a question of a system as of finance. The system to be employed depended upon which would be the cheapest according to local conditions. Herr W. Lahmeyer followed with some information respecting the transmission of current from Offenbach to Frankfort, a distance of six miles, which had been carried out by his firm, and which would have been looked upon as impossible a few years ago. Further inspection of the exhibits was then made, and a luncheon was given in the exhibition.

In the afternoon Herr W. H. Lindley, city architect, Frankfort, read a paper on the various systems of electric tramways. He stated that the expenditure for horse traction averaged from 70 to 80 per cent. of the gross reciepts in Frankfort, while with electric traction the cost amounted to from 40 to 60 per cent. He described electric traction by means of overhead and underground conductors and of accumulators. The last-named seemed the best, but it had failed in Hamburg and Brussels. Experiments, however, were being made with accumulator traction on the "Waldbahn," Frankfort. The fault of the overhead system was that it was ugly and required a network of wires in the streets, while underground conductors had the defect that they suffered from floods, short-circuiting, and so on. Up to the present it had not been decided what was the best system, but electric traction must nevertheless be heartily welcomed.

This subject gave rise to some discussion. A representative of Messrs. Siemens and Halske spoke up for the underground conductor system as carried out at Buda-Pesth, whilst an engineer of the Thomson-Houston Company pointed out that 177 out of the 270 existing electric tramways were on the Thomson-Houston system.

The Opera House was visited in the evening, and the assembly concluded by visiting various municipal works on the 29th inst.

THE TELEPHONE.

[The following letter from the Duke of Marlborough appeared in the *Times* of last Saturday. It is interesting as bearing upon the telephonic papers read at Cardiff.—Ed. *E.E.*]

Sir,—Having made a special study of the telephone for many years, both from its connection with pure science as well as its enormous possibilities as a boon to the public, I venture to crave your indulgence for the following remarks. The paper which was read at Cardiff by Mr. Preece on the Paris and London telephone, and the equally interesting paper that followed from Mr. Bennett on a complete scheme for the telephoning of a large town like London, mark an era in the history of this invention, which is destined before long to be as important a factor in our business and domestic life as the telegraph itself.

The reasons why this wonderful invention has so slowly developed in England are probably not entirely known to the public, and, on the eve of a great development which is now likely to take place, it may be interesting to some of your readers to know what these causes have been in the past and what the progress is going to be in the future.

When the telephone was first started in England, and the Post Office proceeded against the United Telephone Company for infringing the Telegraph Acts, it was decided by the Courts that a telephone message was a telegram within the meaning of those Acts, and that no one had a right to use this invention save the Postmaster-General. The Post Office, however, came to terms with the telephone company, and, on consideration of a 10 per cent. royalty on the gross receipts, the Post Office granted to the new telephone company, and subsequently to other telephone companies, licenses of 26 years' duration. These licenses were of the form of all-England licenses, and were not applicable only to particular districts, and the only reservations contained in them were that the Postmaster-General should not be debarred from entering on the telephone business himself, and that the Post Office should have the right to buy up the telephone industry at a valuation at every septennial period. The first septennial period in the license of the present National Company occurred last year, and I brought the matter to the attention of the House of Lords, and pressed the Government to exercise the power they had and undertake they telephone work of the country as a branch of the Post Office. I had many interviews with the late Postmaster-General on this matter, but it was decided that the sum required to establish the industry on a proper and complete system would be so large that the Post Office did not see their way to undertake the work, besides the fact that owing to the ambiguity of the wording of the purchase clause, it was impossible to say whether the Government, if they served a notice of purchase on the "National," would not have been obliged to pay that company the whole three millions which their share capital had amounted to under the various schemes of amalgamation they had carried out with other companies. As matters are to-day, there is a small development of the telephone going on in some of the large provincial towns of England, but the system is inferior and the cost prohibitive. In London the total number of subscribers does not exceed a few thousand, and these are almost entirely in the City. Practically no development of the telephone for social or business purpose exists, while the price is above the means of the many. In some European towns the telephone enters largely into public use. In a small place like Christiania, for instance, the whole business of the place is done on the telephone, as also is the case in Stockholm. A report from the Consular service, dated 1890, gives a very full account of the use of the telephone in Norway and Sweden. The price does not exceed £4 to £4. 10s. per year to subscribers. In a town like London we might fairly expect that one in 50 at least would be subscribers among offices, shops, and residents.

One insuperable difficulty, however, has existed besides the large cost of £20 a year which the National Company have been charging to subscribers—viz., that the system has been a single-wire system of overhead wires carried on poles above houses, and the return current between subscribers has been taken by the earth. The consequence has been that the telephone has tried the patience of everybody from its inaudibility, while the primitive system of exchanges and the fewness of these exchanges have made the delays in "getting through," as it is called, on the telephone simply intolerable. Every one who has got a telephone in his house to-day is in open revolt against the instrument, on account of its irritating bell and its subsequent failure to make itself efficient as a means of conversation. Now all this is changed when we come to the Paris and London telephone. I have heard the tick of the watch of the person I was speaking to in the Rue de Grenelle from the London General Post Office, and I could have conversed for hours as if I had been in the same room with my correspondent. This telephone is a complete metallic circuit with no earth return. The same result is arrived at wherever the twin wire is used, and Mr. Bennett's plan was interesting in showing that it is easy, at a very moderate cost, to telephone the whole of London on the twin-wire system, and, with the new system of exchange appliances, to do away with all the delays in getting through from one person to another. Moreover, it is demonstrable that this can be accomplished at a remunerative profit for a £10 a year subscription for the whole of the London district of five millions of inhabitants. It is much to be feared that the National Company will never be able to reduce their rate to a £10 level, as all the money they paid for patents should be written off this year, their last important patents having expired. Further, their system being entirely single-wire, with overhead connections, and with no general scheme for dividing London up into central exchanges, it would be necessary for them to relay the whole of their wires and exchanges from end to end before they could extend their system or improve their service to any practical extent.

Another matter of vital importance is to be able to get all main trunk wires underground, and not only free the air from these black monstrosities, but also be able to establish sufficient lines between central and sub-stations. In order to obtain this object, it is necessary to go to Parliament for powers for laying their wires underground. This is about to be done, and a new company, which possesses a license from the Postmaster-General, is about to promote a Bill before Parliament next session with the object of establishing a complete twin-wire telephone service for the whole of London on the basis of a £10 a year rental, and with a system based on the plan worked out by Mr. Bennett, so that the telephone will be available to everybody for their business, their shopping, and their social needs. The scheme is a most interesting one, and, with the possibility of getting all the trunk lines underground, the darkening of the air by large cables will be completely obviated and done away with. We may, therefore, hope before long to realise the plans set forth at the British Association meeting, and be able from our own writing-tables to speak with a friend in his country home, or even discourse with a friend in Paris as to his doings, and also convey our social invitations about town without having to write interminable notes and make numberless cab journeys, often to no avail.

THE BRITISH ASSOCIATION AT CARDIFF.

PRESIDENTIAL ADDRESS BY WILLIAM HUGGINS, Esq.

(*Continued from page 209.*)

Now this state of things, in which the masses, though not equal, are of the same order, does seem to prevail in many nebulæ, and to have given birth to a large class of binary stars. Mr. See has recently investigated the evolution of bodies of this class, and points out that their radical differences from the solar system in the relatively large mass-ratios of the component bodies, as well as in the high eccentricities of the orbits brought about by tidal friction, which would play a more important part in the evolution of such systems. Considering the large number of these bodies, he suggests that the solar system should perhaps no longer be regarded as representing celestial evolution in its normal form—

> "A goodly Paterne to whose perfect mould
> He fashioned them . . ."

but rather as modified by conditions which are exceptional.

It may be well that in the very early stages condensing masses are subject to very different conditions, and that condensation may not always begin at one or two centres, but sometimes set in at a large number of points, and proceed in the different cases along very different lines of evolution.

Besides its more direct use in the chemical analysis of the heavenly bodies, the spectroscope has given to us a great and unexpected power of advance along the lines of the older astronomy. In the future a higher value may, indeed, be placed upon this indirect use of the spectroscope than upon its chemical revelations.

By no direct astronomical methods could motions of approach or of recession of the stars be even detected, much less could they be measured. A body coming directly towards us or going directly from us appears to stand still. In the case of the stars we can receive no assistance from change of size or of brightness. The stars show no true discs in our instruments, and the nearest of them is so far off that if it were approaching us at the rate of a hundred miles in a second of time a whole century of such rapid approach would not do more than increase its brightness by the one-fortieth part.

Still, it was only too clear that so long as we were unable to ascertain directly those components of the stars' motions which lie in the line of sight, the speed and direction of the solar motion in space, and many of the great problems of the constitution of the heavens, must remain more or less imperfectly known. Now the spectroscope has placed in our hands this power, which, though so essential, appeared almost in the nature of things to lie for ever beyond our grasp. It enables us to measure directly, and under favourable circumstances, to within a mile per second, or even less, the speed of approach or of recession of a heavenly body. This method of observation has the great advantage for the astronomer of being independent of the distance of the moving body, and is therefore as applicable and as certain in the case of a body on the extreme confines of the visible universe, so long as it is bright enough, as in the case of a neighbouring planet.

Doppler had suggested as far back as 1841 that the same principle, on which he had shown that a sound should become sharper or flatter if there were an approach or a recession between the ear and the source of the sound, would apply equally to light; and he went on to say that the difference of colour of some of the binary stars might be produced in this way by their motions. Doppler was right in that the principle is true in the case of light, but he was wrong in the particular conclusion which he drew from it. Even if we suppose a star to be moving with a sufficiently enormous velocity to alter sensibly its colour to the eye, no such change would actually be seen, for the reason that the store of invisible light beyond both limits of the visible spectrum, the blue and the red, would be drawn upon, and light-waves invisible to us would be exalted or degraded so as to take the place of those raised or lowered in the visible region, and the colour of the star would remain unchanged. About eight years later Fizeau pointed out the importance of considering the individual wave-lengths of which white light is composed. As soon, however, as we had learned to recognise the lines of known substances in the spectra of the heavenly bodies, Doppler's principle became applicable as the basis of a new and most fruitful method of investigation. The measurement of the small shift of the celestial lines from their true positions, as shown by the same lines in the spectrum of a terrestial substance, gives to us the means of ascertaining directly in miles per second the speed of approach or of recession of the heavenly body from which the light has come.

An account of the first application of this method of research to the stars, which was made in my observatory in 1868, was given by Sir Gabriel Stokes from this chair at the meeting at Exeter in 1869. The stellar motions determined by me were shortly after confirmed by Prof. Vogel in the case of Sirius, and in case of other stars by Mr. Christie, now Astronomer Royal, at Greenwich; but necessarily in consequence of the inadequacy of the instruments then in use for so delicate an enquiry, the amounts of these motions were but approximate.

The method was shortly afterwards taken up systemmatically at Greenwich and at the Rugby Observatory. It is to be greatly regretted that for some reasons the results have not been sufficiently accordant and accurate for a research of such exceptional delicacy. On this account, probably, as well as that the spectroscope at that early time had scarcely become a familiar instrument in the observatory, astronomers were slow in availing themselves of this new and remarkable power of investigation. That this comparative neglect of so truly wonderful a method of ascertaining what was otherwise outside our powers of observation has greatly retarded the progress of astronomy during the last 15 years, is but too clearly shown by the brilliant results which within the last couple of years have followed fast upon the recent masterly application of this method by photography at Potsdam, and by eye with the needful accuracy at the Lick Observatory. At last this use of the spectroscope has taken its true place as one of the most potent methods of astronomical research. It gives us the motions of approach and of recession, not in angular measures, which depend for their translation into actual velocities upon separate determinations of parallactic displacements, but once in terrestrial units of distance.

This method of work will doubtless be very prominent in the astronomy of the near future, and to it probably we shall have to look for the more important discoveries in sidereal astronomy which will be made during the coming century.

In his recent application of photography to this method of determining celestial motions, Prof. Vogel, assisted by Dr. Scheiner, considering the importance of obtaining the spectrum of as many stars as possible on an extended scale without an exposure inconveniently long, wisely determined to limit the part of the spectrum on the plate to the region for which the ordinary silver-bromide gelatine plates are most sensitive—namely, to a small distance on each side of G, and to employ as the line of comparison the hydrogen line near G, and recently also certain lines of iron. The most minute and complete mechanical arrangements were provided for the purpose of securing the absolute rigidity of the comparison spectrum relatively to that of the star, and for permitting temperature adjustments and other necessary ones to be made.

The perfection of these spectra is shown by the large number of lines, no fewer than 250 in the case of Capella, within the small region of the spectrum on the plate. Already the motions of about 50 stars have been measured with an accuracy, in the case of the larger number of them, of about an English mile per second.

At the Lick Observatory it has been shown that observations can be made directly by eye with an accuracy equally great. Mr. Keeler's brilliant success has followed in great measure from the use of the third and fourth spectra of a grating 14,438 lines to the inch. The marvellous accuracy attainable in his hands on a suitable star is shown by observations on three nights of the star Arcturus, the largest divergence of his measures being not greater than six-tenths of a mile per second, while the mean of the three nights' work agreed with the mean of five photographic determinations of the same star at Potsdam to within one-tenth of an English mile. These are determinations of the motions of a sun so stupendously remote that even the method of parallax practically fails to fathom the depth of intervening space, and by means of light-waves which have been, according to Elkin's nominal parallax, nearly 200 years upon their journey.

Mr. Keeler with his magnificent means has accomplished a task which I attempted in vain in 1874, with the comparatively poor appliances at my disposal, of measuring the motions in the line of sight of some of the planetary nebulæ. As the stars have considerable motions in space it was to be expected that nebulæ should possess similar motions, for the stellar motions must have belonged to the nebulæ out of which they have been evolved. My instrumental means, limiting my power of detection to motions greater than 25 miles per second, were insufficient. Mr. Keeler has found in the examination of 10 nebulæ motions varying from two miles to 27 miles, with one exceptional motion of nearly 40 miles.

For the nebula of Orion, Mr. Keeler finds a motion of recession of about 10 miles a second. Now this motion agrees closely with what it should appear to have from the drift of the solar system itself, so far as it has been possible at present to ascertain the probable velocity of the sun in space. This grand nebula, of vast extent and of extreme tenuity, is probably more nearly at rest relatively to the stars of our system than any other celestial object we know; still it would seem more likely that even here we have some motion, small though it may be, than that the motions of the matter of which it is formed were so absolutely balanced as to leave this nebula in the unique position of absolute immobility in the midst of whirling and drifting suns and systems of suns.

(To be continued.)

ON THE TELEPHONING OF GREAT CITIES.*

BY A. R. BENNETT, M.I.E.E.

A matter which has never yet been seriously faced is how the demand for telephonic exchange connection, which, after the lapse of a few more years, is bound to arise in all large cities, is to be met. As yet, the merest fringe of telephony as it will ultimately be when developed has been touched. A time will come when every shopkeeper and almost every householder will require his telephonic exchange connection.

What is possible in this direction under the influence of moderate rates and a reasonably efficient service has already been demonstrated in certain localities, chiefly in Scotland, where towns boasting of next to no manufactures or staple trade possess exchanges far exceeding in importance those of many English towns of three and four times the population, the principal supporters of such exchanges, after the manufacturers and merchants, being professional men, as doctors, solicitors, and accountants; householders; and shopkeepers, as grocers, butchers, and druggists.

As exchanges so composed continue to exist and increase year after year, it may fairly be assumed that the subscribers get back their rentals in some form or another, and it may likewise be argued that what is profitable north of the Tweed would be found equally so south, if the experiment were only tried – as it certainly will be some day.

Then, when that time arrives, and the householders and shopkeepers of London follow the example of, say, those in Galashiels, and come to regard a telephonic exchange connection as necessary to their business as the laying on of water or of gas, a problem will present itself which, although not entirely free from difficulty, will not, in the light of past experience, present any insuperable obstacles.

The efficiency and the readiness with which a large town or city can be telephoned so as to meet the ever-increasing demands of the inhabitants will depend in a very great measure on how the work is laid out and set about in the initiatory stage.

If London were telephoned in the same proportion as Galashiels, it would possess 28,000 subscribers, but that number does not nearly represent the possibilities—far from it. When a city has attained to the size of a nation—for is not London a nation in itself?—it behoves us to look forward. We must certainly anticipate one telephonic exchange connection for every 50 inhabitants in London in time to come—a modest estimate if we consider that there is already one for every 200 inhabitants in Galashiels, and some other towns, which are the merest hamlets in comparison—places in which a pistol-shot will carry from the centre to the green fields in any direction. With London's present population of 5,600,000 such a proportion would represent 112,000 subscribers, and as the population increases and the boundaries extend, more and more will grow the demand, until even that great number will appear inadequate and insignificant.

Every villa in the residential districts, every suburban shopkeeper will be on the exchange, and the telephone will supersede in London, as it has already done elsewhere, the butcher's boy, the grocer's lad, and the baker's man—at least, so far as the daily calling for orders is concerned—and tend to make us more independent than we are at present of the domestic servant.

As the new generation grows—a generation familiarised from its cradle with the word "telephone," and the idea of conversing at a distance with all and sundry, and, consequently, free from the prejudices and old-fashioned methods which have, in very many cases, deterred their fathers from availing themselves of the new agent—every young man starting in business will order a telephone connection at the same time that he orders his fuel, light, and water, just as a matter of course; and if time is found at all for speculation on such a commonplace subject, it will be devoted to wondering how his steady-going progenitors did without it.

As an indication of how the telephone idea is taking root, I may mention that the builders of a new block of business offices in Manchester propose to put a permanent connection to the Mutual Telephone Company's exchange into each suite of offices, paying the subscriptions themselves, and charging their tenants nothing extra. This is one of the first-fruits of cheap rates.

The possible demand being conceded, the question arises, "Can it be met; and, if so, how?" I answer that it can, and I propose to show how.

The establishment of an effective and popular telephone exchange in a large town, and one that can be added to and extended freely and economically, without pulling down what has already been done, involves the fulfilment of several indispensable conditions.

Firstly.—Speech must be loud and distinct, and privacy of communication complete; and a subscriber's line and apparatus must be adapted equally well to speaking to another across the street or to one 500 miles away. There must, furthermore, be an absence of all disturbing sounds.

Secondly.—The arrangements for connecting the subscribers together, subsequently disconnecting them, and, if required, immediately reconnecting them to others, must be so complete that eight or 10 seconds should be the maximum time occupied within the compass of the largest town.

Thirdly.—The rates must be within the reach of even small householders and shopkeepers, and should not exceed £8 per annum.

Fourthly.—The general design must permit of the addition of new subscribers in every direction and to any extent, without interfering with the work already done.

All these conditions can be complied with. What is necessary to do to meet them can be broadly indicated under three headings.

1. The universal use of metallic circuits, and the absence from the line of intermediate electromagnets and other signalling devices, which tend to damp and deform the electrical vibrations which constitute telephonic speech.
2. The provision of means by which certain and instantaneous communication can be established between subscriber and operator, and between one operator and another.
3. The division of the town to be telephoned into districts or sections not exceeding a square mile in area, each of which is worked from a switchroom placed at or near its centre.

The fulfilment of these necessary conditions is easy, provided the undertakers, whomsoever they may be, are in possession of the right to open the streets of the town and lay their conductors in the same way as gas, water, electric light, and, in some instances, hydraulic and pneumatic power conductors are laid.

So long as the execution of any scheme is subject to the caprice or the blackmailing propensities of individual proprietors, a proper telephonic service, such as London, the first city of the world, ought to possess, will remain an aspiration and nothing more. It has always been a bugbear of telephonists in this country that they have to fix their wires, not where they want them, but where they are permitted to. A British telephone exchange system is consequently, generally speaking, the result of a constant endeavour to reconcile the desirable with the impracticable—a compromise rarely, if ever, satisfactory.

Legislative assistance to the extent of placing the undertakers of telephone exchange systems on an equal footing with the ministers to other public wants is indispensable to the carrying out of a scheme designed, not only to meet the requirements of the moment, but those of a reasonable number of years to come.

I am not one of those who believe that there is no design in the conduct of the universe—that railways and steamboats are because they happen to have happened, or because, Newcomen, Trevithick, Watt, Stephenson, and Symington chanced to have ideas—that telegraphs are because Gauss and Weber, Cooke and

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* Paper read before the British Association.

Wheatstone, and Morse, were scientific enthusiasts—that telephones are because Reiss, Varley, Bell, Edison, and Hughes were covetous of fame, fortune, or notoriety.

No! Railways and steamers, telegraphs and telephones, are means adopted by the Great Designer to meet the needs of growing populations—to render possible the feeding and clothing of the ever-increasing millions—to lay under contribution for their benefit the uttermost parts of the earth. They make the world larger by increasing its capacity for population, and, at the same time, smaller by quickening communication. The means at the command of our fathers a hundred years ago would not suffice to feed the populace of to-day. Famine and pestilence, without such beneficent provisions, would have kept back the multiplication of the human race; a certain stage would have been reached, but, without the new appliances, never passed. The process is still going on, and will not stop at telephones we may be sure. The future has greater wonders in store than any we have so far seen. Some are already casting intermittent scintillations of their brilliance before—just as telegraphs and telephones were talked of ages ago. It has been truly said that the dreams and fairy tales of one generation become the everyday commonplaces of the next.

Starting with the admission that the telephone is neither a fad nor a luxury, but a providential provision for man's use and benefit—a practical, earnest, matter-of-fact instrument, which has come to stay—we may likewise assume that it is not possible to stifle it, to relegate it to oblivion, or even to curtail its natural extension. Sooner or later it will be universally recognised that the general use of the telephone has to be provided for, and the legislative sanction I am now advocating will be granted in order that such an excellent servant may be turned to the best account.

Without such legislative assistance, which, I contend, cannot consistently be withheld, seeing that it is granted as a matter of course to railway, tramway, and other companies, the efficient and economical telephoning of great cities verges so near to the impossible that, during the remainder of my paper, I shall assume that it will be forthcoming at the proper time.

As already indicated, the system of the future for all large towns must be founded upon the use of multiple switchrooms, each serving its own immediate neighbourhood.

All the subscribers' lines will then be short and economical to construct, while the switching apparatus, owing to sub-division, will be simple and cheap. These conditions will enable the annual payments by subscribers to be kept down to a minimum

All subscribers' lines will be metallic circuits. To the British Post Office (in the person of Mr. W. H. Preece) belongs the honour of being the first to insist on the necessity of double wires for telephone exchanges. The Post Office exchanges have always been constructed on that plan, and, until a few months ago, they were singular in that respect, and the only ones in Great Britain to which a British technical man could refer with any gratification. Some of the National Telephone Company's exchanges have not been without merit, but being single-wire ones, their foundations were as quicksand, and no amount of ingenuity expended on the superstructures could compensate for such a radical defect At best, the faults inherent in the system could be palliated, not cured.

So long ago as 1883 I warned the National Telephone Company of the error they were committing in persisting in the use of the single-wire system, and pointed out how it was then possible to change gradually and economically to metallic circuits. The opportunity was lost, and now cannot be regained without sacrificing the greater part of the capital they have expended.

When the Mutual Telephone Company started in Manchester I advised them to have nothing to do with single wires, but to secure privacy and freedom from disturbing noises by using nothing but metallic circuits. The advice was taken, and universal commendation has resulted.

To obtain an efficient service with multiple switchrooms by the aid of the switching apparatus ordinarily used in this country, with its intermediate electromagnets and numerous complications, would be out of the question. A radical departure from existing practice must be made in this, as in other particulars. Fortunately, the way out of the difficulty lies ready to our hand

For a good many years now a system known as the "Mann" has been operated with the greatest possible success in several districts, principally in Scotland. This system is unrivalled in many respects. It enables connections to be obtained with certainty and celerity; it renders easy the task—on some of the older exchanges an arduous and frequently impossible one—of getting rid of one connection and obtaining another. It simplifies and cheapens switching apparatus to an almost incredible degree, and it permits of connections being made through many switchrooms without the intervention of intermediate electromagnets, so that no retardation and indistinctness of speech results. The system possesses other conspicuous merits, but it is unnecessary to enlarge on them here.

In one respect—and in one only—is the "Mann" system apparently more complicated and more expensive to instal than the ordinary. It necessitates the taking into each subscriber's office of a branch from a common service wire, on which all communications with the operators are conducted, and the addition to each subscriber's instrument of an extra piece of apparatus.

But the complication is more imaginary than real, while the extra cost of the service wire and fittings is saved many times over in the switchroom, where an infinity of complicated and expensive apparatus is dispensed with, and where faults, and attendance by skilled electricians, are reduced to a minimum.

The main feature of the system is the service wire already mentioned. One such wire is allotted to every 60 to 100 subscribers, according to the amount of traffic passing. During the busy hours of the day operators are always listening on the service wires, so that subscribers may speak and be heard without any premonitory signals. By means of specially-constructed telephones, weighing but a little over 2oz., attached to the head by springs, the girls are enabled to listen continuously without fatigue, and at the same time keep both hands free for operating purposes. The subscriber, on his part, can at any moment place himself in communication with the operator by depressing a small lever, which has the effect of changing his instrument temporarily from his main line to the service wire.

The mere depression of the lever suffices to secure her attention at any moment, so that mistakes can immediately be rectified and an explanation asked of any delay. The operators have not to do any ringing at the exchange, the subscribers working their own call-bells, thus leaving the girls to perform only the acts of connecting and disconnecting, a feature which greatly contributes to the rapidity for which the system is famed. A deal of labour is also saved by the absence of the ordinary shutter indicators, the putting up of which, after they have been dropped by the subscribers, constitutes a large part of the operator's work with other systems. The general plan of the service wire is shown in Diagram I. The operator's phone is always earthed; those of the subscribers only when their levers are depressed.

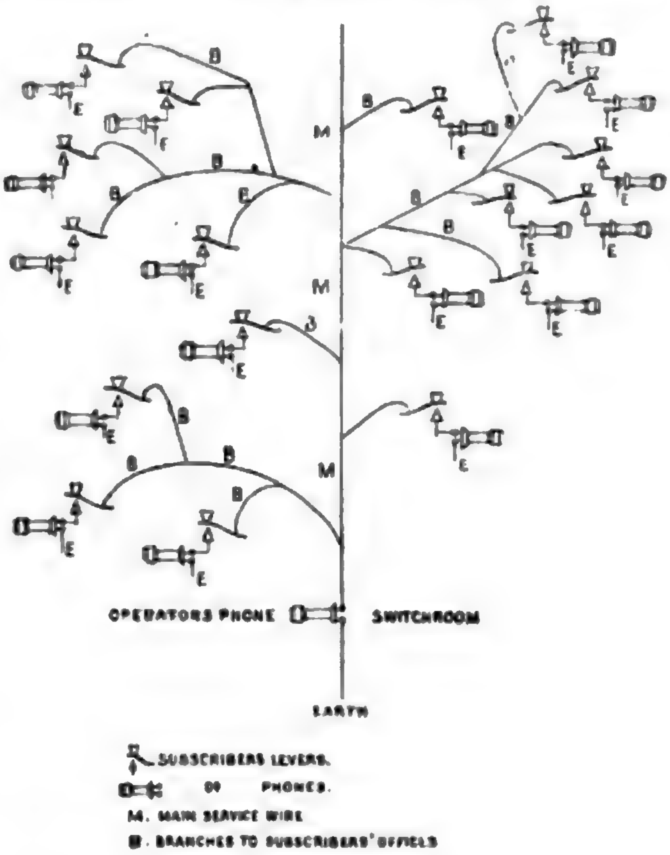


DIAGRAM I.

During the night and slack hours the operators do not listen continually, but the depressing of the subscriber's lever makes a signal which the operator can respond to so quickly that she is ready to listen as soon as the subscriber is to speak.

The marked superiority which this system had shown over every other in Scotland during the years 1883-90, induced the Mutual Telephone Company to adopt it for their Manchester exchange. It was accordingly introduced there in February last, and has already established itself firmly as the best in the estimation of the subscribers.

The experience gained at Manchester has enabled the one objection to the "Mann" system—the necessity of taking an additional wire into each subscriber's office—to be overcome.

After having designed and partially constructed the Manchester Mutual Exchange on the "Mann" system, it occurred to me that it might be possible to convey the service messages between subscribers and operators by means of electrostatic induction between the subscriber's metallic loop and a special single wire run out for a sufficient distance from the exchange amongst each group of metallic circuits.

On arranging the wires and apparatus in the manner indicated in Diagram IV., it was found that such a plan was really practicable. The connections of the subscriber's instrument were altered in such a way that on depressing the lever the metallic circuit (represented by M in the diagram) was put to earth through the telephone. The metallic circuit then acted as a single wire of double area, and whether insulated at the switchboard or connected through to another circuit practically formed one plate of a condenser, the other plate or plates of which were any of the adjacent wires that happened to be earthed at their extremities.

It was therefore only necessary to put the operator's instrument in permanent connection with one or more wires running parallel to the subscriber's metallic circuit for a short distance, to enable any of the subscribers, whose instruments were so fitted, to communicate with the operator by depressing their levers.

levers were not depressed, the telephones were looped in the metallic circuits as usual, and the operators could neither hear nor be heard.

When cables were used containing 36, or even 72 metallic circuits, it was only necessary to connect the operator's phone to a single wire placed in the centre of the cable, or to the metallic wire on which the operator at the next switchroom is listening. (Diagram V.)

The phenomenon utilised for so conveying the service messages is the one which, under the name of induction, has always been the bane of telephonists, and I believe it has never been turned to a useful account before.

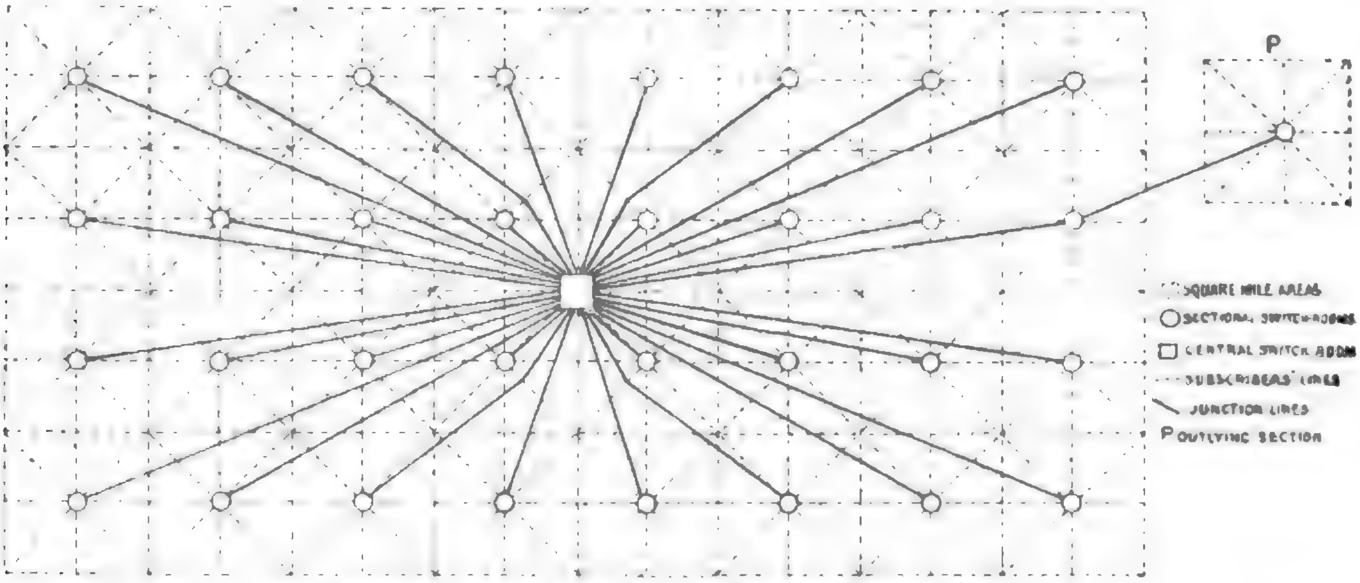

P
SQUARE MILE AREAS
SECTIONAL SWITCH-ROOMS
CENTRAL SWITCH ROOM
SUBSCRIBERS' LINES
JUNCTION LINES
P OUTLYING SECTION

Diagram II.—Plan of Town with One Central Switch Room.

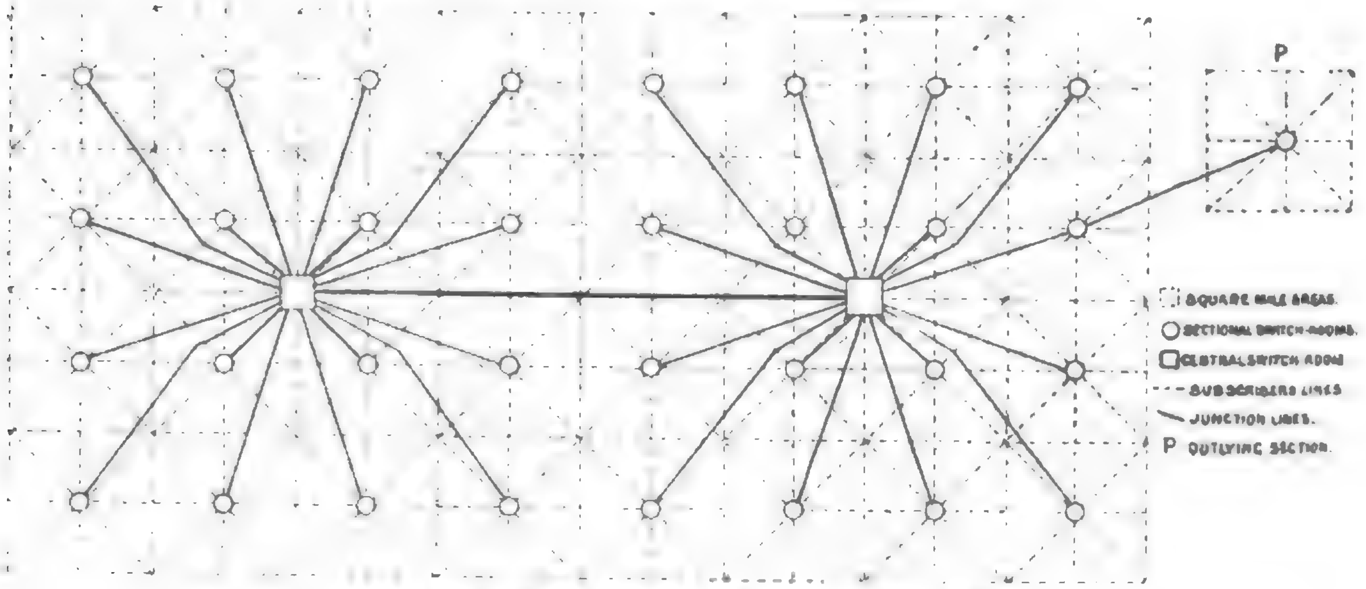

P
SQUARE MILE AREAS.
SECTIONAL SWITCH-ROOMS.
CENTRAL SWITCH ROOM
SUBSCRIBERS LINES
JUNCTION LINES.
P OUTLYING SECTION.

Diagram III.—Plan of Town with Two Central Switch Rooms.

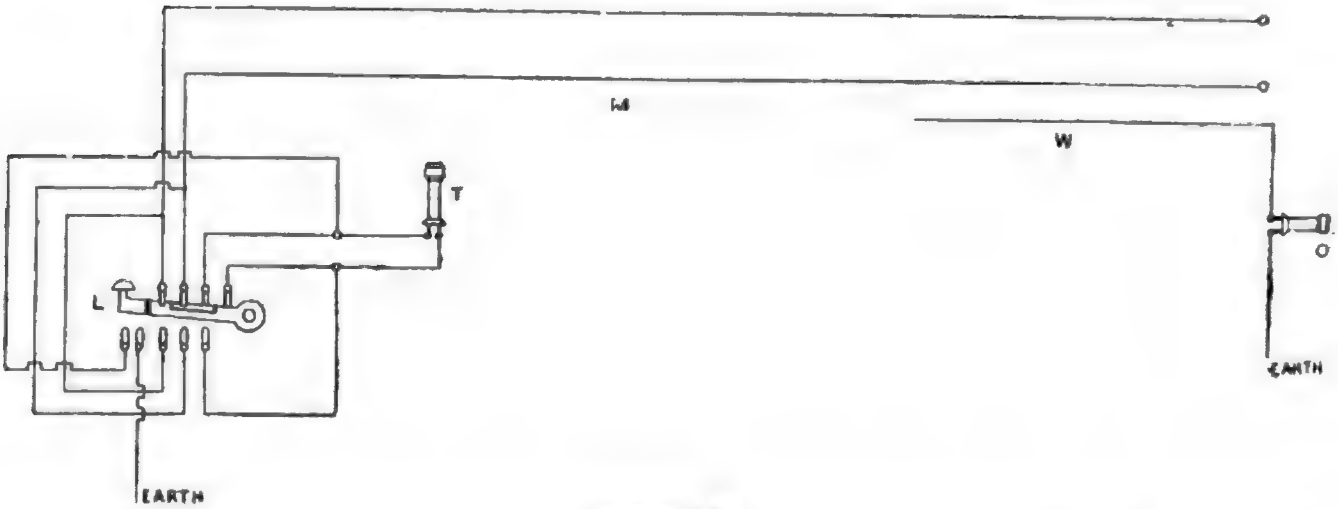

M
W
T
L
O
EARTH
EARTH

Diagram IV.

M, Subscriber's Metallic Circuit, forming, when lever is depressed, the Subscriber's side of the Condenser. L, Subscriber's Lever, changing his Phone from Metallic Circuit to Earth. T, Subscriber's Phone. W, Insulated Wire, forming Operator's side of the Condenser. O, Operator's Phone.

sheathing of the cable, to obtain perfectly good speaking when the metallic loops were earthed by the subscribers depressing their levers.

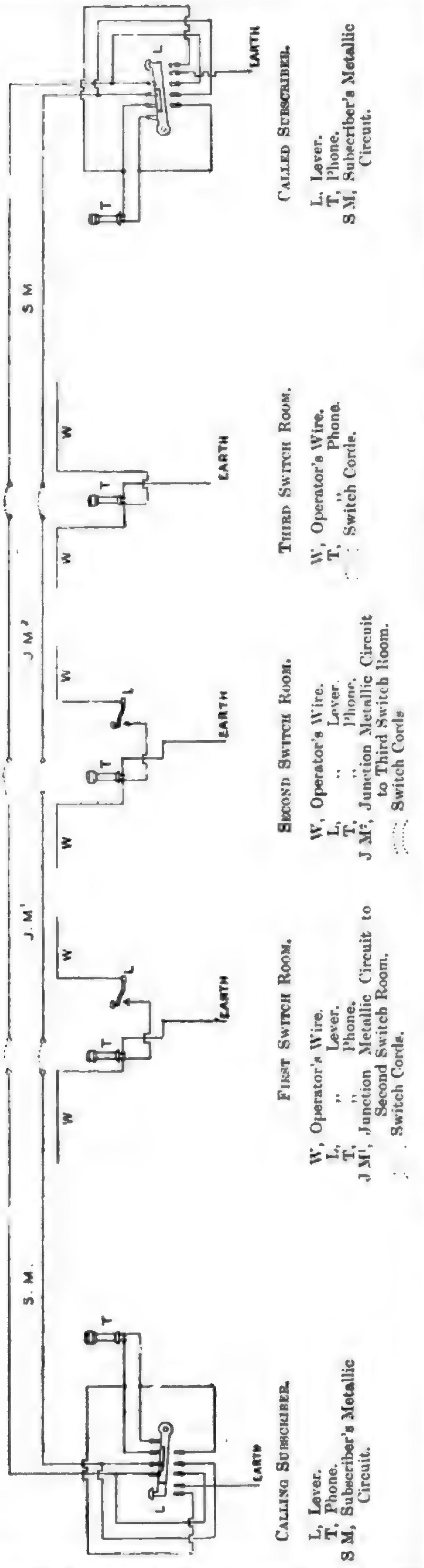
When a connection has to be obtained through more than one switchroom it is asked for by each operator in succession by depressing a lever which puts her in communication with a service wire into each subscriber's office, thereby saving expense and permitting of thinner leads being employed.

With this plan it becomes unnecessary to take a separate service wire into each subscriber's office, thereby saving expense and permitting of thinner leads being employed.

I have recently devoted considerable thought to the problem of telephoning a great city like London.

I have taken as a groundwork an area of 32 square miles, mea-

DIAGRAM V.



CALLING SUBSCRIBER.
L, Lever.
T, Phone.
S M, Subscriber's Metallic Circuit.

FIRST SWITCH ROOM.
W, Operator's Wire.
L, " Lever.
T, " Phone.
J M¹, Junction Metallic Circuit to Second Switch Room.
: Switch Cords.

SECOND SWITCH ROOM.
W, Operator's Wire.
L, " Lever.
T, " Phone.
J M², Junction Metallic Circuit to Third Switch Room.
: Switch Cords.

THIRD SWITCH ROOM.
W, Operator's Wire.
T, " Phone.
: Switch Cords.

CALLED SUBSCRIBER.
L, Lever.
T, Phone.
S M, Subscriber's Metallic Circuit.

suring eight from W. to E., and four from N. to S. Such an area would comprise the greater part of London, from Shepherd's Bush to Limehouse, and from Primrose Hill to Kennington Oval, and include the chief of the telephonic wealth of the metropolis. Such portions as lie beyond are comparatively poor, and can be dealt with readily by special offshoots from the main system.

Comprising, as it does, the heart of London, such an area would contain the whole, suburbs and all, of any other city in the world. My remarks apply, therefore, to any large town, and the scheme curtailed will fit any town smaller than London.

In considering my plan I have kept steadily in view the conditions I have stated to be indispensable, putting efficiency first and economy second, although, as it happens, I have found the two march well together; so that the working out of my plan, especially if permission to place wires underground is obtained, will be found quite compatible with earning a good dividend on £8 rates. With the Mutual system vanishes the whole costly and complicated paraphernalia of American switchroom apparatus which has been so blindly copied in this country. As an instance of the economy effected, I may mention that in a switchroom fitted for 5,000 subscribers the first cost per subscriber on the American plan is about £3. 10s. for switching apparatus alone; on the Mutual plan adopted at Manchester, the cost per subscriber is about 10s. The difference in cost of maintenance is even more striking, while the efficiency is altogether in favour of the cheaper method.

On the American plan each 100 subscribers occupy 9·9 square feet on the switchboard; on the Mutual plan, the space required for 100 is exactly 5¼in. square. An American switchboard for 5,000 subscribers is 162·5ft. long, and it occupies 325 square feet of floor space. A Mutual board of the same capacity is 44ft. 10½in. long, and occupies 104·7 square feet of floor space. A Mutual board, consequently, costs about one-seventh, and occupies less than one-third of the space of an American. The matter of privacy has been so specially studied that with the Mutual switchboard the operators cannot "tap"—that is, listen to conversation between subscribers—an operation which, with American boards, can be performed continually and continuously without the subscribers being any the wiser.

As already indicated, I propose to telephone any large town by dividing it into sections about a square mile in area. It will not be possible to adhere rigidly to such a division in practice, as parks, rivers, and open spaces will often intervene, and in very active commercial quarters, like the City of London, smaller sections, perhaps as many as four to the square mile, would no doubt be found desirable; but an approximation to the plan will always be possible, and allowances such as these can be made without departing from the principle.

In the centre of each square I would place a switchroom, making thirty-two sectional or branch switchrooms in an area of thirty-two square miles.

According to the configuration and general requirements of the town, I would establish one central switchroom, as in Diagram II.; or two such rooms, as in Diagram III.

This would give thirty-three or thirty-four switchrooms, as the case may be, for the town.

The subscribers in each section would be connected, each by a metallic circuit, to their appropriate switchroom, and the sectional switchrooms would, in their turn, be connected to the central rooms by as many metallic circuits as the traffic passing through them may be found to require. These metallic circuits, joining the sectional switchrooms to the central, I call junctions. When two centrals are used, as in Diagram III., they are connected together by additional junctions. In addition to the junctions, there would be, between the switchrooms, a sufficient number of service wires—that is to say, metallic circuits reserved entirely for service communications between the operators.

The mode of operation may be either the "Mann" plan pure and simple, or the modification of it which I have described. The latter would be the more economical, as it saves a wire to each subscriber.

At the sectional switchrooms, operators would always, during busy hours, be listening on the service wires for orders from subscribers, or from the central; at the central, operators would similarly be listening for orders from the sectional operators.

The subscribers' lines could be distinguished, as is usual, by numbers, each sectional switchroom having assigned to it 5,000 numbers, the first room having numbers 1 to 5,000; the second, numbers 5,001 to 10,000; so on to the thirty-second, which would accommodate numbers 155,001 to 160,000. This would give a skeleton list more than sufficient for one telephone to 50 inhabitants, and would take a good many years to fill up. Further expansion than this we may safely leave to our children to deal with, but the placing of new switchrooms midway between the old suggests itself as an appropriate method of meeting any demand in excess of the capacity of the square-mile scheme. Subscribers object most strenuously to any change in the number they have been accustomed to, and the necessity of making such changes can only be provided against by adopting a comprehensive scheme to begin with. The use of very high numbers could be avoided by assigning each switchroom a distinguishing name or code-word, and numbering its subscribers from one upwards.

The junctions between switchrooms would also be known by numbers prefixed by a name, or code-word, which should preferably be of one, or at most two, syllables, since it would have to be repeated thousands of times a day, and indicate the locality of the section—such as, Chelsea, 1, 2, 3, etc.; Tower, 1, 2, 3, etc. Sections that cannot be indicated well in a short word may be known by the names of colours—red, blue, etc.

The central switchroom need not be exclusively reserved for operating junctions. It would probably be found advantageous to connect direct to it subscribers in its immediate vicinity, and for these a separate switchboard could be provided.

The work required to obtain a connection would depend on the locality of the calling and called subscribers, and, while in every case extremely expeditious, would be more so in some cases than in others.

There would be three classes of calls:

CLASS I.—*From a subscriber to another situated in the same square-mile section and connected to the same room.*

The work would consist in the caller depressing his lever and repeating to the operator (who would be always listening) his own number and that of the man wanted, as "20 on 400." With this class of call connection should be effected in two seconds, and a smart operator would manage it in one.

CLASS II.—*From a subscriber on any sectional room to one joined direct to the central.*

In this case the caller would depress his lever and say to the listening operator, "20 on 6,400." The sectional operator immediately depresses a lever, which puts her in connection with a second operator listening at the central, and says, "6,400, Blue 12," Blue 12 being a junction between her board and the central, which she sees at a glance to be disengaged. While speaking she would peg No. 20 through to Blue 12. The central operator, on receiving the message would know that she was required to connect subscriber No. 6,400 to her end of junction Blue 12, an operation which she can perform in one second. Such a connection should be got through in six seconds at the outside.

CLASS III.—*From a subscriber on any sectional switchroom to one on any other.*

This requires an additional repetition. The caller depresses his lever and says to his sectional operator, "6,200 on 19,406": the operator repeats the latter number to the central, adding the name of an unoccupied junction, as "19,406, Willesden 2," at the same time making the necessary connection on the board. The central operator in her turn depresses a lever which puts her on to a listening operator at the sectional room to which No. 19,406 is connected, and repeats the number with the name of a junction to that room which she sees to be free, as "19,406, Richmond 23," which junction she simultaneously joins to "Willesden 2." The Richmond sectional operator pegs No 19,406 on to junction 23, and the connection is through. The average time occupied should not exceed 10 seconds, and in practice will frequently be less. This estimate is based on the tests described in the Appendix, which were especially designed to ascertain the average time occupied with connections coming under this third class—that is, those requiring the co-operation of three operators. I am so satisfied as to the accuracy of these and many other tests that I should be prepared to guarantee a 10-second service between the most distant sections of an area as large as London if telephoned as described. Experienced operators will dispense with much of the speaking. Thus they agree to work the junctions connecting their respective exchanges in rotation, beginning with No. 1. They remember which they used last, so find it unnecessary to mention a number when asking a connection, both taking the next as a matter of course. They know each other's voices, so that it is superfluous to mention the sectional name. Thus, the last connection would be got through frequently in this way:

Subscriber to first operator	"6,200 on 19,406,"
First operator to second operator ...	"19,406,"
Second operator to third operator .	"19,406,"

all the rest being understood.

The skill often attained by a girl who begins switching at the age of 13 or 14 is perfectly marvellous. When listening on the service wire, some of them can comprehend and execute without mistake two distinct orders spoken simultaneously by different subscribers. When a subscriber gives an order in the usual formula of "No. So-and-so on So-and-so," the girl frequently inserts the first switchplug in the hole corresponding to the first number before the second has been spoken, and the connection is completed by the insertion of the second plug almost before the subscriber has ceased to speak, and certainly before he has time to take his finger off the service lever.

On finishing their conversation the two subscribers depress their levers, and, giving their respective numbers, say "off," as "6,200 off," and "19,406 off." On hearing, the sectional operators remove the connecting pegs and free both the subscribers' lines and the junctions for further connections. The sectional operators could also give the word "off" to the central, thus "Willesden 2, off," and "Richmond 23, off," but this would only be necessary when so busy that the demand for junctions is in excess of the supply, which would never be the case on a well-managed exchange. It usually suffices if the sectional operator in a spare moment notices which of her junctions are still engaged, and says to the central "All off but So-and-so and So-and-so."

Districts lying beyond the 32 square mile area, in which it may be necessary to open rooms, can be attached to the general system and served as rapidly as any of the home sections. Such an outlying square is shown in Diagram II. As in all the others, an operator will always be listening for subscribers' orders, and there will be junctions, together with service wires, to the nearest switchroom within the home area. The service wires will be joined permanently to the service wires from the home sectional switchroom to the central, so that on the outlying operator asking a connection from either the sectional operator or the central, she will be heard by both. If the connection is one with which the sectional girl can deal, the central takes no notice. If, on the other hand, the subscriber wanted must be had through the central, the operator there will give the connection on a junction, which the sectional operator will indicate by a word, as it were, *en passant*. Thus, the calling subscriber depresses his lever and says, "24,002 on 15,008." The outlying operator depresses a lever which connects her to both the home sectional and the central operator, and says, "15,008, Ilford 4." The home sectional girl adds, "Stratford 19," and the central girl knows that she has to give subscriber No. 15,008 on junction Stratford 19, to which the sectional operator has already joined Ilford 4, on which the outlying operator has put subscriber 24,002. The whole can easily be managed in 10 seconds.

An analysis of the movements required to complete a connection by the Mutual as compared with the American system, brings out the merits of the former very strongly, and sufficiently accounts for its superior rapidity.

AMERICAN SYSTEM. *Through One Switchroom.*	MUTUAL CO.'S SYSTEM. *Through One Switchroom.*—Corresponding to Class I.
1. On seeing drop fall, operator turns down table key. 2. Plugs into caller's jack and speaks. 3. Test lines of called subscriber and, finding it free, 4. Inserts plug. 5. Depresses ringing key to signal called subscriber. 6. Replaces table key. 7. Replaces fallen shutter. 8. On receiving ring-off signal removes plugs. 9. Replaces ring-off shutter.	1. On receiving caller's order through telephone (always to her ear) operator tests called subscriber's line, and, finding it free, 2. Inserts plugs. 3. On receiving the word "off" removes plug.
Total 9.	Total 3.
AMERICAN SYSTEM. *Through Two Switchrooms.*	MUTUAL CO.'S SYSTEM. *Through Two Switchrooms.*
The number of movements would be double that for one switchroom, or 18.	1A. Operator A receives caller's order and inserts plug in a junction she sees to be free. 2A. Depresses key and repeats order to operator B, 3. Who tests called subscriber's line, and, finding it free, 4. Inserts plugs. 5. On receiving "off" operator A removes her plugs. 6. Operator B does likewise.
Total 18.	Total 6.
Through Three Switchrooms	*Through Three Switchrooms.*—Corresponding to Class III.
The number of movements would be thrice that for one switchroom, or 27.	1A. Operator A receives caller's order, and inserts plugs, using a junction she sees to be free. 2A. Depresses key and repeats order to operator B. 3B. Operator B inserts plugs, using a junction she sees to be free, and 4B. Depresses key and repeats order to operator C, 5. Who tests called subscriber's line and finding it free, 6. Inserts plugs. 7. Operator A receives "off" and removes plugs. 8. Operator C receives "off" and removes plugs. 9. Operator A gives "off" to operator B. 10. Operator B removes plugs.
Total 27.	Total 10.

NOTE.—Movements 1A and 2A and 3B and 4B are simultaneous, one being done with the left, the other with the right hand.

It is evident, therefore, that, roughly speaking, there is about three times the work with the American than with the Mutual system, and that the latter has but one more movement in getting a connection through three switchrooms than the former has through one. The plan I propose is adapted to give a quicker service than the American one, even supposing the mechanically and financially impossibe plan of concentrating all the subscribers lines in one huge central switchroom were adopted. It is this fact that enables me to advocate with the fullest confidence a multiple switchroom plan as the best means of telephoning a great city. The modified Mutual system in combination with such switchrooms solves the problem of how to deal with very large exchanges. It enables the greatest simplicity to be maintained throughout. It contains within itself the principle of indefinite expansion, and the larger the number of subscribers it has to cope with the more conspicuously do its merits shine out.

The size of the switchrooms would be kept within reasonable limits, and the apparatus consequently would be simple and cheap. The largest would be the central, but even this would have to deal with only 40,000 lines when the maximum of 160,000 subscribers came to be reached, allowing the very liberal proportion of 25 per cent. cf junctions I apprehend no difficulty whatever in arranging 40,000 lines in one room. The floor space required would only be about twice that now wanted for 5,000 lines on the American plan.

The rent and other expenses of so many switchrooms may be urged as an objection, but I do not consider it at all a serious one. Small apartments would suffice for the sectional rooms; many of them would be in cheap neighbourhoods, and all could be top floors or attics.

It may also be said that the number of operators required would be great; but so it would be with any system, and the wages of a few score of girls are neither here nor there when the economies otherwise effected, and the prize to be won by any company giving a good and cheap service in such a town as London are considered.

Such a service would, I believe, produce a circle of between 30,000 and 40,000 subscribers in the course of three or four years. But supposing that London only managed to attain the present level of Galashiels within that period, the number would be 28,000. This, at £8, would mean a gross annual revenue of £224,000, and, deducting 50 per cent. for working expenses, a net revenue of £112,000. Capitalised at 5 per cent., the sum represented would be £2,240,000, or £80 for each subscriber connected. How such an amount could be expended I cannot imagine. With a switchroom in the centre, or nearly so, of every square mile, the average length of the subscribers' lines would be only a quarter of a mile. The cost of wires, instruments, and switchroom fittings would be £10 per subscriber at the outside. Debiting each subscriber with another £10 as his share of the cost of the junction lines and central, there would remain a balance of £60 per subscriber for conduits, labour, and miscellanous expenses. I repeat that I do not know how such a sum could be spent, and I believe that after a short experience a subscription of £8 would be found unnecessarily high, and capable of substantial reduction. But to ensure such a result, the systematic working out of a definite plan must be insisted upon. There must be no patching of patches, and the first object of the undertakers must not be to make money by hook or by crook, but to establish an efficient exchange. That done, the rest will follow of its own accord, and the reward will be rich exceedingly.

Mr. Preece has shown us how efficient telephonic communication can be established with Paris and other distant towns; and one consequence of the adoption of such a system as I have described would be that London subscribers would be able to speak from their own offices and houses to the offices and houses of subscribers in Paris. The adoption of metallic circuits in Brussels and many other continental towns would bring them also within range. Without metallic circuits the scope of long-distance telephoning is restricted within much narrower limits; for instance, London subscribers cannot at present speak to those in Manchester or Liverpool, except by the aid of special apparatus corresponding to that which I would make universal.

The success of the Mutual Telephone Company in Manchester may be cited as an instance of what is possible with low rates and a good service. The rate is £5 to shareholders, and £6 to others, and the average is very nearly £5. 10s. The exchange commenced working on February 28th last with 68 subscribers. On June 30th there were 413 subscribers connected, and the net profit on the month's working for Manchester centre was at the rate of 4·64 per cent. per annum; on July 31st the number connected was 506, representing a revenue of £2,840, and the profit on the month's working was at the rate of 5·04 per cent. per annum. At the same date the amount expended on the Manchester exchange was £12,469, scarcely £24. 12s. per subscriber, which sum not only represented the cost of joining up the 506 subscribers, but included provision for future developments on an exceedingly liberal scale.

I think, therefore, that there is reason to believe that telephony may be both good and cheap at the same time, and that in the future it will be both.

APPENDIX.

On an existing exchange worked according to Mann's system, each operator in ordinary course of business deals with 180 connections per hour, or exactly three per minute, of which about half have to be obtained from, or given to, operators at other switchrooms. On a special trial being made, by several inspectors being put on an operators' service wire, with instructions to supplement the ordinary traffic by demanding connections incessantly, the operator successfully dealt with 357 connections in exactly one hour. She therefore got through 5·95 per minute for 60 consecutive minutes, which gives an average for each connection, including subsequent disconnections, of 10·09 seconds. Of these she completed 92 herself, 223 had to be asked from another switchroom, and 42 were given to another switchroom. All the usual incidental work was properly performed, such as informing callers that the subscriber wanted was engaged ringing up callers, and notifying that the subscriber previously advised as engaged could now be had; answering repeated demands from impatient callers for engaged or dilatory subscribers; informing operators at other switchrooms that subscribers wanted could not be had, with the reasons, and subsequently advising that they were free.

Special tests were made to ascertain the rate at which connections involving the attention of three different operators (corresponding to Class III. of the proposed London system) could be completed and subsequently got rid of. For this purpose a model conversation was arranged, each subscriber on being rung up being told: "This is the telephone manager's office; is there one of my inspectors at your place just now?" Two tests were made, in each case 20 consecutive connections being demanded with subscribers taken at random from the list, except that only those were selected whose connections, owing to the position of their premises, would have to be handled by three operators. It was agreed beforehand, that if any subscriber called for left his bell unanswered for 60 seconds the experimenter would tell the operator to disconnect and give another. The tests took place during busy hours of the day, and were imposed on the ordinary traffic.

Test A.—Twenty connections were made, but the twelfth subscriber asked for did not answer within the regulation minute, so that only 19 model conversations were held. The first connection was asked at 10h. 1m., and the twentieth was done with at 10h. 19m. 40s. Deducting one minute lost over the subscriber not obtained, the average for the 19 conversations had was 55·8 seconds.

Test B.—Twenty connections were asked for, but one subscriber was engaged, and two others did not answer within the regulation minute; consequently only 17 model conversations were held. The first connection was asked at noon precisely, and the twentieth was done with at 12h. 14m. 20s. Deducting three minutes lost over the three not obtained, 17 conversations were completed in 11m. 20s., giving an average of 40 seconds per conversation. Of the 680 seconds occupied, only 136 were taken up in asking for and making the connections; the balance was consumed in ringing the subscribers called, by their delay in answering, in putting the model question, and receiving the replies which were not always confined to a monosyllabic negative.

Erratum.—In Mr. Preece's paper on "The London-Paris Telephone," published in our last issue, in the last paragraph—page 212—the figures 1·8 and 3 should read ·18 and ·3.—Ed. *E. E.*

Discussion on the Papers of Mr. Preece[*] and Mr. Bennett.

Major-General Webber said that in such a paper as they had heard from Mr. Preece they were at a disadvantage, because the reader was naturally tied down by his official position, and did not give to himself or those with whom he was associated—they being public officers—all the credit that they deserved. No doubt many of those present had watched what had been called long-distance telephony, as accounts came out in the public press from year to year. They had seen reports of experiments that had been made between Paris and Brussels, associated with names which he need not mention there; and perhaps they had wondered that during so long a period no great success in establishing long-distance telephony had been achieved at an earlier date It was owing to Mr. Preece and to those connected officially with the telegraph departments of Great Britain and France, assisted by that great factor the public purse of both countries, that long-distance telephony had been made a success; and that chiefly for the reason that those gentlemen early saw that it was necessary to have a metallic return. Those who investigated the subject in previous years had in view the utilising of existing telegraph lines, all of which had earth returns, and all their efforts were in that direction. The credit of showing that a metallic return was necessary was due to their chief electrician, as also was the inducing of those who had charge of the public purse strings to incur the necessary expenditure to enable it to be done in the way in which Mr. Preece had described. The achievement which Mr. Preece had described was one of the most marvellous public works of this kind that had been undertaken in this country and in this century. As regarded Mr. Bennett's paper, he was sorry it had not been read *in extenso* as it deserved. He also thought that a great many present had not been able to realise the value of what he had brought before them. He had described the Mann system of telephone exchanges, or rather he would have done so if he had had time. The whole question was one that was very much before the introducers of the telephone in this country in 1880. At that time the advantage of a metallic return was well known. But it was a serious question to those who had to find capital for the establishment of telephone exchanges in the towns of Europe to incur the cost of two wires to every subscriber. The cost of one wire was, say, £10 per mile, and the doubling of that for a large system meant a very considerable outlay. He must admit that, being largely interested in that establishment, when he had to give his vote he gave it in favour of one wire and earth returns. The effect of induction and other difficulties had since brought about the conclusion that the double wire was the best. He thought this was the natural result of experience, and he was glad to see that people were going to use this system. But they must also recollect that the Mann system necessitated a third wire, not a third wire to every subscriber, but one between, say, 50 or 60 subscribers; and, therefore, increased expenditure per subscriber was necessary in the shape of capital outlay on lines. While the application admitted at once of the simplification of the exchange room, the complication of lines was to a certain extent increased. The really interesting point in Mr. Bennett's paper was the discovery—he believed he was right in calling it his (Mr. Bennett's) discovery—that had been pointed out to them in Diagram IV. It was a most interesting outcome of his investigations and experience, because, admitting that the Mann system was the best, this saving in a branch wire into every subscriber's office was an important factor in the success of the scheme. But Mr. Bennett did not give credit to one essential feature of the system he (the speaker) advocated in 1883, at the Society of Arts. He pointed out that the great delay in telephone exchanges was due to a system which had been brought to this country by persons who had only started exchanges in America, and had not found out one fundamental error, and that was that all telephone exchanges were worked by the switchroom—that is, the central office—having to call up a subscriber, and it was that which caused delay. But once the public had been educated to follow this system, it was extremely difficult to change them. He advocated the closing of all the offices and starting anew. The success of Mr. Bennett's system was mainly due to teaching subscribers it was their duty to call up their correspondent directly. As soon as they were taught to do that they would get rid of all delay, and as soon as that was recognised in a few exchanges the rest would soon follow. There was no doubt that the double-wire system, together with the essential part of the Mann system, would simplify telephonic work in the future. Mr. Bennett described how the young lady in the switchroom had two little telephones attached to her ears, by which means she was placed in communication with 50 or 60 subscribers, and by which a considerable amount of the switchroom apparatus was saved; but when they came to consider what it would mean to have wires attached to your ears in communication with 50 or 60 persons he must say it was a very serious thing. Mr. Bennett told them that the young ladies had acquired the art of not going mad in a wonderfully short time, and if they began at 15 or 16 they would never have to be sent to a lunatic asylum. He must say that it was a detail to be overcome, no doubt, but it was likely to be problematical. Mr. Bennett told them that this difficulty of facing the demand for telephonic exchanges in large cities like London had never been faced before. He would remind him that in 1880 he (the speaker) laid out the City of London for 200 exchanges, and plans were published at the time.

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[*] Mr. Preece's paper on "The London-Paris Telephone Line" was given in our last issue.

Mr. Davey said that Mr. Preece, who was responsible for overcoming the difficulties of the London-Paris line, had not told them all the difficulties. He would like to ask Mr. Preece whether one of the great difficulties was not that of sending a message through a submarine cable. He thought a mechanical illustration of assisted induction might serve to rivet on their minds the great benefit which had been derived from what Mr. Preece had told them was the greatest improvement in the system. He had shown them two diagrams, one to illustrate what he (the speaker) might call resisted induction, and the other assisted induction. If they drew two parallel lines and put two geared wheels between the wires and touching them (assuming them to be geared together), and applied force to the periphery of one wheel, it would resist a force which was applied in the opposite direction on the periphery of the other wheel. That was, if they put in an even number of wheels geared together, they had an illustration of resisted induction. But if they put in an odd number they got assisted induction.

Prof. Silvanus P. Thompson said they were greatly indebted to Mr. Preece for his clear description of the London-Paris telephone, and he quite agreed with General Webber that they ought to credit Mr. Preece with a little more than his own modesty had claimed. He and his coadjutors in the General Post Office deserved great credit, not only for the work done in this particular extension of the telephone, but for the work they did years ago—more particularly in Newcastle, when they led the way to the establishment of exchanges on a more rational plan than that which came over from America. They were so apt to think that American electricians led the way — they told them they did, and occasionally they were believed for want of further information. Now the fact was, they (the English) led the world in telephonic work, and not the Americans. Mr. Preece and the Post Office officials at Newcastle established a better way of laying out an exchange than the American plan, and their Scotch friends had still further improved on it. The British Post Office, moreover, had availed itself of still further improvements that had been made in signalling. He had the misfortune to differ from Mr. Preece as to the theoretical working of telephonic circuits, but that did not prevent him from admiring the good work he had done. Mr. Preece had said that he did not know to whom was due the credit of using a shunted condenser. He thought if Mr. Preece would refer to an old work, *Kreller's Journal*, he would find a paper by Helmholtz, about 1850, in which the effect of using a shunted condenser for stopping sparks, or the effects of electromagnetic inertia, was clearly pointed out. He was glad that Mr. Preece had accepted the proposition that retardation due to induction was antagonistic, in a certain sense, to the retardation due to actual capacity. He had told them that a condenser properly shunted could be made to counteract the effects of self-induction. He wished that Mr. Preece would believe that induction could counteract the effects of capacity. The reason why they could telephone through lines having capacity was because of induction. That rather difficult proposition was laid down by Mr. Oliver Heaviside; he (the speaker) found it very hard, and he knew that Mr. Preece had not accepted it. Their attention was drawn to the very pretty mechanical method of illustrating assisted and resisted induction; he would point out that it had been given in Prof. Oliver Lodge's "Modern Views of Electricity." This showed them that the energy was not propagated up one copper wire and down another, but across the medium.

A Member asked Mr. Bennett whether it was possible to reconstruct existing exchanges by substituting double wires for single without pulling them to pieces; or whether it would be necessary to do as they had done in Manchester—viz., make a new exchange altogether? In that case the enormously watered capital of the National Telephone Company, which amounted to about three millions of money, would be absolutely useless. Would the present company be able to put up double wires without producing a loss of capital?

Mr. S. F. Walker congratulated Mr. Preece on the results he had obtained, and asked if he had had any trouble with leakage on the London-Paris line. As to Mr. Bennett's paper, he had long been of opinion that the question of the increase of telephone exchanges must be faced sooner or later. As soon as the monopoly had fully expired there was no doubt there would be an enormous development. Everybody would have telephones if they could have them cheap. But no matter how much branch centres were multiplied, the more the subscribers were increased the more they must multiply their connecting lines; and he thought when they got beyond a certain point the rate must go up or the dividend would go down, unless they could save the increased cost in another way. He was very pleased to find Mr. Bennett tackling the subject. Attendance was one of the biggest charges, and if Mr. Bennett could reduce its cost in the way he suggested, without sending telephonic young ladies into lunatic asylums, he would put universal exchange work several degrees forward.

Mr. Blakesley asked as to Diagram 4, in which Mr. Preece gave a longitudinal section of the line. He had put the telephone at St. Margaret's Bay in shunt and the telephone at Sangatte in shunt. If he (the speaker) understood aright, the St. Margaret's Bay telephone was in shunt when used to London, but when anybody was talking to Paris it was not necessary to shunt it. This was very interesting, but he thought that fact could not be taken as universally true. It would be better that telephones should be in series in other cases. The way to decide whether they should be, depended upon certain properties of the cable itself. In Fig. 1 there was some mistake. He supposed Mr. Preece did not mean that the current began to fall or rise suddenly and ended suddenly? It began gradually and reached its maximum gradually. He was very glad Mr. Preece had arrived at the principle of the use of the shunted condenser. He (the speaker) worked out the theory of the condenser in series and shunt circuits in 1884. Prof. Thompson had mentioned that somebody else had used a shunted condenser before, but he did not think they gave the theory of it. Sir William Grove made very remarkable experiments with a condenser, but it was for sending large currents into the primary of a Ruhmkorff coil by means of an electrical machine, and getting extraordinary sparks in the secondary. He knew the effect was produced by the condenser, but he did not attempt to explain it. He (the speaker) would have liked to have made further explanations. The whole thing was very interesting, but it required a better memory than he had to carry the facts of the case in his head.

Mr. Gavey briefly described the system used by the Post Office. It consisted of a metallic loop and signalling arrangements, a small shutter held up automatically by the current, and a small indicating needle. If the renter wanted the attention of the telephone exchange, by pressing a button the shutter fell and the ordinary connections were made. When the renter had completed his conversation, the mere act of restoring the telephones or tubes to the rests sent an automatic current, which, deflecting the needle in the indicator, advised the clerk at the room that the conversation was complete and the connection severed. Mr. Bennett suggested in his paper that electromagnets introduced in a telephone circuit caused trouble. Under certain circumstances, yes. But they could always be so disposed as to cause no trouble whatever. His general experience of the introduction of electromagnets in the Post Office system, with indicators in short circuits, such as were used in towns, was that they had no evil effect. If they were introduced on long trunk lines the effect would be to very much dull the speech, and, perhaps, to render it utterly impossible. But this could always be overcome by using indicators of high resistance and great self-induction, and by bridging them across the line, much as they saw the telephone bridged across in Fig. 4 in Mr. Preece's paper, instead of putting them directly into circuit. When that was done, the effect on the speech was absolutely inappreciable. The rapid telephone currents did not traverse the indicators at all, whereas the slower ringing currents were distinctly felt. The system hitherto introduced into this country had always been to minimise, if possible, the number of exchanges in a town, because if these were multiplied delay was always introduced in putting one exchange in connection with another. With many exchanges the switch clerk had to connect a renter through his switchroom and through one, or perhaps two or three others, and when he was through the reply came that the person wanted was engaged, and all the work was wasted. So that when they could have direct lines all centreing on one exchange, though the cost might be increased, the efficiency of the service was increased also. He would venture to say, therefore, that in all towns of moderate size the most efficient service on the whole would be one that centred the whole of the wires in the town into one exchange. In towns of enormous size the cost of a service of that character would be absolutely prohibitive. Mr. Bennett had indicated one method of multiplying exchanges which was certainly very promising, and might be developed later into a very useful system.

Mr. J. Head said Mr. Preece had shown them that telephone lines of 500 to 800 miles could now be made and worked with perfect success. They were all very much interested in being able to talk from London to Berlin, and so on, but they were most of them still more interested in being able to talk from one part of their own country to another. 800 miles included the most distant parts of that country. Would Mr. Preece's experience encourage him to say that within a measurable distance of time the local exchanges in the country would be so connected as to enable them to talk with their friends wherever they might be in the United Kingdom?

A Member asked what was the distance over which telephone messages could be sent in America.

Mr. Wallace, alluding to the important remark made by Mr. Preece, that in the future all telephone wires must go underground, said that this would take some time to do, but it must be one of the objects which all persons who wished to construct proper exchanges must have in view. Of course, it could not be done by the National Company without expending a tremendous amount of extra capital, and doing away with practically the only asset they had left out of the money they had spent. Perhaps Mr. Preece would tell them whether it could be done by the Post Office. As to the inter-connection of towns, too, he would like to hear something from Mr. Preece. He thought they might take it that they would be obliged to have metallic returns in the local exchanges, as Mr. Bennett had already pointed out.

Mr. Preece, in replying, said he would take the questions put to him *seriatim*. Mr. Davey hinted that he did not refer to the submarine cable as an obstruction. As a matter of fact he had done so, because he always put the cable as part and parcel of the whole circuit, and when he used the term K he included that. Cables were a very great obstruction, simply because the electrical capacity they possessed bore such a very large ratio to that possessed by the rest of the circuit. They had found that the 23 miles of cable across the Channel had not been a great obstruction. In the case of a proposed circuit between London and Brussels, a cable of 60 miles would prove a rather serious obstacle. Prof. Thompson referred to *Kreller's Journal*. He was a mine of information. If anybody wanted to know the history of any matter electrical, there was the man. If they wanted anything written about the history or the theory of electricity there was their philosopher and friend; and although he had then heard for the first time that Prof. Helmholtz—the greatest living authority—had introduced matters relating to condensers, he would go to his friend and learn all about it in a very short time. Prof. Thompson accused him of not accepting, or of neglecting something. All that he knew was that in electrical matters he invariably accepted truth. If it turned out that he was wrong, he willingly changed his view, but he had seen more nonsense written on that subject of self-induction than any other in the English language, and the reason was that the writers on electricity did not always apply the same term to the same thing. They were not even agreed as to the use of the simple letter L. It was not always used to imply the same thing, and the result was that some of Prof. Silvanus Thompson's friends might have used L to indicate the very reverse of what he (the speaker) did. He would find out from him, and if he was wrong he would withdraw anything he had said. As it was, his paper said that there were conditions where induction favoured the transmission of speech, and that was why they spoke so well. Prof. Thompson had referred to the assistance he (the speaker) had received from the Post Office officials in carrying out those works. He did not believe that in any service in this world there was a finer body of men than in that of the British Post Office. And if there was any branch in which their capabilities came to the front more than another, it was in the electrical branch. They had that day had some remarks from his oldest friend in the Post Office and his ablest assistant—Mr. Gavey—who had charge of the telegraphic arrangements in that part of the country, and there was no part of the country where telephony had been carried out to greater perfection than down there. All the towns of the valleys of South Wales, Swansea, Newport, Bristol, etc., were in direct communication with each other, and all the principles of clear speech had been carried out there in their highest order. In Newcastle, again, there was Mr. A. W. Heaviside, in Liverpool Mr. Edwards, and in London Mr. Cooper and Mr. Brown. The sole object of these men had been to benefit the public service and to show that good work could be done. Prof. Blakesley did not understand Diagram 1. It was an attempt to indicate the appearance of the current as it was received at the distant end of the circuit. For instance, if they sent a current from Ireland to America on the submarine cable, it was recorded by a Thomson recorder, and the line of the recorder was a curve very much like that. He had carried out a heap of experiments in recording telephone currents. They were so delicate that the absolute currents could not be recorded, but by the use of a very powerful primary current and by the aid of recorders they had been able to record a speech. He was sorry to say that he had left these records behind him in London, but he would have very great pleasure in showing them to Prof. Blakesley. That mode—shown on Diagram 4—was practically the only way of connecting up telephones to work. In that case they utilised the self-induction in air. Mr. Gavey had described how they connected up any number of telephones in bridge or shunt, so that intermediate instruments did not affect the circuit at all, but were assistant rather than resistant. Mr. Head asked a question as to the possible future of telephonic enterprise in this country. He was quite right; it was perfectly possible to connect together any two towns, and to place them within decent speech of each other as good as that in London and Paris; but the obstacle was an important one. It was not L electromagnetic inertia, but £ s. d. The difficulty was not that that £ s. d. was not to be found in the coffers of H.M.'s Government, but, as it happened, the telephone interests in this country were in the hands of private companies. It was for them to spend their money in carrying out long-distance circuits between town and town; unless the public, through the House of Commons, could show that they were better served by the Post Office, then, as a member of the Post Office, he (the speaker) would be only too glad to connect Mr. Head's town in the north with his town in the south. He thought he had answered Mr. Wallace's question, and as to Mr. Walker's, there was no doubt that leakage had a beneficial effect. He thought it was Mr. Oliver Heaviside who in one of his papers pointed out that the polarisation effect of leakage must have a beneficial effect, and no doubt it had, as they spoke better in wet weather than in dry. In reply to another question, they did talk between New York and Chicago—a distance, he believed, of 800 miles—but he did not think it was commercial. He thought the greatest distance over which commercial speech was carried on was between New York and Boston, a distance of 300 miles.

Mr. Bennett said he would begin his reply by apologising to General Webber, for it was within his knowledge that General Webber contrived and planned a scheme for telephoning London as far back as 1880. But, unfortunately, his advice on that subject was not taken, and the result was the fortuitous concourse of telephones, now known as the London telephone system. General Webber was under the impression that the young lady operators objected to always listening at the telephones. The reverse was, in fact, the case. By the ordinary system the wants of the subscribers were made known by the dropping of little shutters, and it was necessary for the girls to be perpetually replacing those shutters after they had been dropped, and this was very fatiguing in a long day's work. With the Mann system all shutters were dispensed with. The girls had light telephones attached to their ears, their hands being free, and they had really nothing to do but to sit still, listen, and move their hands; whereas with the American system they had practically to be jumping about all day long. The skill attained by some of these girls was very marvellous. Some of them could actually take messages from two subscribers simultaneously, and understand them both. General Webber thought that it would perhaps be very inconvenient if 50 or 60 calls came at the same moment. So it would, and he did not imagine they could manage 50 or 60; but, as a matter of fact, such a thing never happened. When a subscriber put down his lever to give an order to the operator, should another subscriber have his lever down, the other instantly knew the fact. The formula for giving orders was a very short one; it occupied about one second. The calling subscriber gave his calling number, "400," and added, "on 20"; that occupied but a very short time. Subscribers got into the habit of waiting for each other; and such a thing as 50 or 60 speaking together was quite out of the question. In reply to another questioner, he did not think it was at all possible for the National Telephone Company to alter their existing wires to metallic circuits. As Mr. Preece had told them, not only was it essential to have a metallic circuit, but it was necessary to erect these circuits in a certain way, in order to get the benefit of the double wire. Now, it would be necessary for the present single wires not only to be doubled, but their position on the standards and poles would have to be altered entirely, so the cheaper method would be to take them down altogether and erect new ones. The company's present supporting poles and standards would come in, but the cost of changing single to double wires would, in his opinion, be as much as the construction of a new system would cost. There was another difficulty about it. It would be impossible to change the single wires into double ones at once. The process must go on gradually, and grave difficulties would arise, because it would be necessary to still retain subscribers with single wires to speak to those who had double ones. This could only be done by the insertion of translators, of which a very large number would have to be provided, and the switching arrangements would be very gravely complicated. In 1883 he advised the National Company to effect such a change, but their wires were then few; now the aspect had changed altogether. Mr. Walker thought that the multiplying of trunk wires would be a very costly matter. Of course, they could not put down new junction wires without spending money; but then, it must be recollected, the necessity for these junction wires would not arise until the number of subscribers had increased. Every subscriber would, of course, pay an annual rental, and that annual rental would go to find the necessary dividend on the cost of new junction wires. He could say this with the greatest confidence, because he had had practical experience of the matter. Mr. Gavey had pointed out how it was possible to combine electromagnets with telephonic circuits without spoiling the speaking. He did not say it was not possible to do that. What he said was, it was not done. The American system was followed in this country almost blindly without any alteration, and a part of that system was the introduction of electromagnets on the wires at the switchroom. Every electromagnet took away from the efficiency of speaking, so that with the present system, if several switchrooms had to be spoken through, or several towns, the result would be that the efficiency of speaking would be perhaps altogether destroyed. He had known that expensive trunk lines between important towns 50 or 60 miles apart, costing thousands of pounds, had lain inoperative for months, simply because the American system of retaining magnets in connection with trunk lines was adhered to.

The Aluminium Company.—The palmy days of aluminium are apparently gone, if we may judge from the statements of the chairman of this Company at the annual meeting on Wednesday. When the Company was formed, he said, the price of aluminium was from 60s. to 70s. per pound, but the price had since fallen to from 6s. to 8s. a pound—a price lower than the estimated cost of production. At that price, even with their improved processes, they could not make it at a profit, and he doubted if anybody was making a profit out of it. The only hope, therefore, for them was in the sodium branch of their business. In that they had a monopoly. They were now engaged in protecting the new uses of sodium, so that even if that monopoly were challenged, they had still something to fall back upon in the hold which they might be able to have in these new uses. Their financial position was weak, but he did not despair of overcoming all difficulties.

CAUSES OF VARIATION OF CLARK STANDARD CELLS.

The following table was inadvertently omitted from Mr. Swinburne's paper on this subject, given in our last issue. The table was referred to on p. 215, col. 1.

TESTS OF PASTES AND CELLS.

No.	22/7/91.	23/7/91.	24/7/91.	24/7/91.	25/7/91.	29/7/91.		30/7/91.	2/8/91.	
						Quiet.	Agitated.		Quiet.	Agitated.
1,650	0·9994	...	0·99975	1·00000	1·00000	1·00000	...	1·00000	1·00000	...
1,651	High.	...	High.	High.	High.	High.	..	...	...	...
1,652	No circuit.	...	Low.	Low.	Low.	Low.	..	...	...	...
1,653	0 99965	...	0·9995	0 9997	0·9997	0·99958	0·99979	0·9999	1·0010	...
1,654	1·00000	...	1 00000	1 00000	0·99989	1·00000	...	...	1·00000	...
1,655	1·0003	...	1·00002	1·00000	1·000014	1·00000	1·000077	..	...	...
1,656	High.	...	High.	1·0012	1·0011	1·00042	1·00091	1·00025	1·00045	1·00045
1,657	High.	..	High.	High.*	1·0011	0·99867	Low.	...	...	...
1,658	...	High.	1·00235	1·0004	1·00143	1·00077	...	...	1·00158	1·0021
1,612	...	0·99775	0·99725	0·9994	...	.	...	...	...	...
1,674	...	...	...	1·00015	...	0·99951	0·99923	...	0·99965	0·9993
1,675	...	...	...	1·00000	1·0007†	0 99951	0·99951	...	0·99925	0·99815
1,679	...	...	..	...	..	0·999272	0·999065	0·99927	0·99925	...
1,681	...	...	...	...	...	1 00043	...	..	...	..
1,685	...	...	...	...	...	...	...	...	0·99698	0·99893
1,688	...	...	...	...	...	...	...	...	0 99875	0·9985

* Shaken up with zinc carbonate. † Not altered by shaking up.

PROVISIONAL PATENTS, 1891.

AUGUST 24.

14238. **An improved method of insulating and laying electric light conductors underground** John Farquharson, Woodland Cottage, High-street, Acton.

14266. **Improvements in appliances for the administration of electricity to horses for curative purposes.** Moses Humm and Arthur Egbert Humm, Leslie House, Westbourne-road, Forest Hill.

14273. **Transmitting signals by means of an electric current, known as "Shadowgraph."** George William Hart, 35, Stodman-road, Newark-on-Trent.

14295. **Apparatus for protecting electric installations for telegraphic, telephonic, and lighting purposes from the effects of lightning or discharges of atmospheric electricity.** George William Spittle, 28, Southampton-buildings, London. (Complete specification.)

AUGUST 25.

14322. **Improvements in portable electric light holders.** William Wallace Savage, 110, St. James's-street, Brighton. (William Wallace Savage, Canada) (Complete specification.)

14355. **Improvements in telephones.** Cæsar Vogt, Temple-chambers, London.

14379. **Improvements in methods and apparatus for giving increased life and efficiency to arc light carbons.** Nathan Morrison Garland, 45, Southampton-buildings, London. (Complete specification.)

14386. **Improvements in or appertaining to electric motors.** George Cecil Dymond, 6, Lord-street, Liverpool. (Ludwig Gutmann, United States.) (Complete specification.)

14388. **Improvements in and relating to electric motors.** George Cecil Dymond, 6, Lord-street, Liverpool. (Ludwig Gutmann, Germany.) (Complete specification.)

14390. **Improvements in dynamo-electric machines.** Sebastian Ziani de Ferranti, 24, Southampton-buildings, London.

14391. **Improvements in couplings for insulated electrical conductors.** Alfred Shedlock, 24, Southampton-buildings, London.

AUGUST 26.

14397. **Improved electric wire insulating composition.** James Stuart Palmer and Frank Stuart Palmer, 78, Clova-road, Forest Gate, London.

14409. **Improvements in microphonic transmitters.** Gustave Binswanger and Herbert John Coates, 71, Queen Victoria-street, London.

14444. **Improvements in apparatus for the supply of motive power to electric generating stations and other works.** George Forbes, 24, Southampton-buildings, London.

AUGUST 27.

14462. **Improvements in electrical appliances for automatically specifying any predetermined temperature.** Enoch Smith, Bank-chambers, Waterhouse-street, Halifax.

14508. **An improved arc lamp.** John Seaton Warburton, 49, New-road, Grays, Essex.

14509. **Improvements in electrical transmission of power.** Benjamin Joseph Barnard Mills, 23, Southampton-buildings, London. (Harry Ward Leonard, United States.)

14517. **Improvements in microphones.** Siemens Bros. and Co., Limited, 28, Southampton-buildings, London. (Siemens and Halske, Germany)

14518. **An improved construction of primary battery.** Henry Weymersch, 28, Southampton-buildings, London.

14520. **Improvements in electroliers.** James Collins, 47, Lincoln's-inn-fields, London.

14525. **Improvements in electric safety lamps for mines.** Charles Nestor Gauzentés, 22, Southampton-buildings, London.

AUGUST 29.

14585. **The use of asbestos in the working of electrical fittings.** R. H. Newington and E. Priddle, 4, Berry-street, Clerkenwell, London.

14596. **Improvements in telephonic switching apparatus.** Ernest Frank Furtado and Grist and Turner, 53, Gracechurch-street, London.

SPECIFICATIONS PUBLISHED.

1890.

11601. **Obtaining metals by electrical action.** Cowles. (Matthiessen.) 8d.
11962. **Electric bells.** Lancaster. 8d.
12439. **Electric lamps.** Shepard. 11d.
15191. **Incandescent electric lamps.** Pauthonier and l'Incandescence Electrique Société. 4d.
15673. **Telephonic switching and signalling.** Fraser. 1s. 1d.
15921. **Incandescent electric lamps.** Dick and MacLean. 8d.

1891.

6846. **Printing telegraphs.** Linville. 1s. 7d.
11144. **Printing telegraphs.** Van Hoevenbergh. 8d.
11519. **Diaphragms for electric cells.** Le Sueur. 4d.

CITY NOTES.

Brazilian Submarine Telegraph Company.—The receipts for last week amounted to £4,739.

West India and Panama Telegraph Company.—The receipts for August show a decrease of £951 as compared with the corresponding period.

Eastern Telegraph Company.—The receipts for August were £53,398, as against £52,606 for the same period of 1890, an increase of £797.

City and South London Railway.—The traffic receipts for the week ending (and including Sunday) August 30 were £716. 19s., against £728 for the week ending Aug. 22.

Eastern Extension Telegraph Company.—The receipts for August amounted to £41,791, as against £46,526 in the corresponding period, showing a decrease of £4,735.

Western and Brazilian Telegraph Company.—The receipts for the past week, after deducting 17 per cent. payable to the London-Platino Brazilian Company, were £3,215.

Direct Spanish Telegraph Company.—For the half year ended June 30 last the Directors recommend the payment of a dividend at the rate of 10 per cent. on the preference shares, and at the rate of 5 per cent., free of income tax, upon the ordinary.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Brush Co.	—	2¼
— Pref.	—	2
India Rubber, Gutta Percha & Telegraph Co.	10	19½
House-to-House	5	5
Metropolitan Electric Supply	—	10
London Electric Supply	5	1[illegible]
Swan United	3¾	4¼
St. James'	—	6¾
National Telephone	5	4⅜
Electric Construction	10	7¼
Westminster Electric	—	5¼

NOTES.

Sophia.—The contract for electric lighting in Sophia is stated to have been awarded to the firm of Egger and Co.

Budapest. — The Municipality of Budapest have decided to replace 20 per cent. of the present public gas lamps by electric lamps.

Belgrade.—The concession for the electric lighting of the town of Belgrade has been awarded to the firm of Tzikos, Pericles, and Case.

Southend.—The Southend Technical Instruction Committee have appointed Mr. G. J. Burch, B.A., to give a course of instruction on "Electricity."

Bengal Telegraphs.—A new telegraph line is to be built from Rampore Hat to Nya Dumka, which is at present isolated from the network of wires in Bengal.

Cork.—The non-attendance of a quorum at the Cork Corporation meeting on Tuesday caused the question of the application for a provisional order to be put off till to-day.

Egremont.—The Egremont Local Board announce further preliminary correspondence with regard to the proposed electric lighting, but the matter has not yet been decided.

Electric Tanning.—Several works for the electric tanning of hides, says the *Bulletin International*, are at full work in South America, especially in the Argentine Republic.

Bushbury.—A curious item comes from Bushbury, where it appears a meeting of the inhabitants met in the Electric Construction Company's works and decided to light 20 lamps—by gas.

Austrian Electrotechnical Institutes.—Two new electrotechnical institutes have recently been opened in Austria, at Gratz and at Brunn; three others already exist, one at Vienna and two at Prague.

Tower System of Lighting.—The system of placing arc lamps on towers, instead of distributing the lamps along the streets, received its quietus in the taking down of the towers in Detroit, where the system was most advocated.

Electrometallurgy.—A work, entitled "Traité d'Electrometallurgie," by M. H. Ponthière, professor of electrometallurgy and industrial electricity at the University of Louvain, is just published by Gauthier Villars, 55, Quai des Saint-Augustins, Paris, price 10f.

Phosphorescence.—M. Henri Becquerel is studying the phenomena of phosphorescence of minerals under the influence of light and heat, and hopes shortly to be able to announce information which may have an important bearing on the development and storing of radiant light energy in its most intense forms.

Dalton (Lancs.).—At the Lighting Committee of the Dalton Local Board last week, letters were read from Messrs. Nicholson and Jennings, the Manchester Edison-Swan Company, Limited, Messrs. J. D. F. Andrews and Co., and from the United Electric Light Company, respectively, in reference to street lighting by electricity.

French Submarine Cables.—The contracts for the manufacture and laying of two cables from Marseilles to Oran, and Marseilles to Tunis, respectively, have been awarded thus: Oran, to the Société Générale des Telephones, for the sum of 2,471,525f.; and Tunis, to M. Grammont, Pont-de-Chérni, Isère, for the sum of 2,650,000f.

New Electrical Books.—Messrs. Whittaker and Co. are about to publish a small work entitled "A First Book of Electricity and Magnetism," by W. Perren Maycock. The work is intended for the use of elementary science and art and engineering students and general readers. The same firm have a comprehensive work on the "Telephone" in the press.

Maidstone.—At a meeting of the Maidstone Local Board held on Wednesday, the committee for electric lighting reported that they had a very long conference with a consulting engineer and discussed the application to light certain areas on trial. They recommended that the steps already commenced for obtaining a provisional order be continued.

Electric Mining.—An interesting item from the mining districts of Colorado says that the Virginius Company have contracted with the Edison Electric Company for the erection of a plant for the transmission of 95 h.p. a distance of 3½ miles over the range of mountains 14,000ft. high. Electricity will supersede steam in several of the neighbouring mills very shortly.

Electric Fog Signalling.—Another invention to carry out fog signalling by electricity is being introduced by Mr. Henry Ramsay Taylor, of Lessels and Taylor, 50, George street, Edinburgh. This constitutes a simple means of ringing an electric bell on the engine as long as the signal is at danger. It is actuated by a brush contact or wheel, and the contacts are worked automatically from the signal-box.

Thomson-Houston Meter. — The Société des Compteurs Cauderay et Frager—controlling the patents of the electric meters of these names—have made arrangements with M. Thurnauer, the Paris representative of the Thomson Houston International Electric Company, for the rights of construction and selling of the Thomson meter, which gained the first prize at the recent municipal competition.

Electric Motors for Quick-firing Guns.—Electric motors, it is stated, have recently been applied to Gatling guns, to make these automatic in their action. The results have been surprising. With a current of 80 volts and about 30 amperes, the motor making 150 revolutions, 1,500 shots per minute can be fired, which is far too rapid for ordinary purposes. A regulator is arranged to diminish the rapidity to any desired.

Electric Tabulating Machines.—Mr. Herman Hollerith, the inventor of the electrical tabulating machine, which has been used in making up the returns of the United States census, has shipped to Vienna the final instalment of the order for a dozen of his machines to be used in making up the returns of the Austrian census. It is said that this order came unsolicited, as did also one from Canada for five machines.

Elevated Electrical Railways for Berlin.—The Berlin correspondent of the *Daily Chronicle* says that Messrs. Siemens and Halske, the eminent firm of electrical engineers, have submitted a proposal to the Minister of the Interior and the Berlin Municipality for the construction of elevated electrical railways throughout Berlin and the suburbs. They propose to construct eight different lines, covering some 40 miles, at an estimated cost of 84,000,000 marks.

Errata.—Our attention has been called to a somewhat awkward misplacement of the diagrams, on pages 138 and 164, in Mr. Kapp's paper on "Electrical Transmission of Power." Fig. 9 should be Fig. 11, 10 should be 12, 11 should be 10, 12 should be 13, and 13 should be 9. As they stand they render the lecture (otherwise perfectly clear and easily followed) rather hard to understand. Perhaps our readers will kindly mark their copies in accordance.

Telephone in Kent.—Since the amalgamation of the South of England Telephone Company with the National Telephone Company, the telephone system has made great progress in Kent. A line is being worked down from London, and will cross the Thames at Gravesend, and from thence will be carried from Chatham to Maidstone, whilst a branch line is being constructed to Minster. The work is being carried out under the direction of Mr. Burden, the district manager.

An Electric Garden Pump.—Messrs. Merryweather and Sons, of 63, Long-acre, have a novelty in small pumps, worked by the electric current. As many of our country seats are now supplied with electric lighting machinery, it may be well to consider how the electric energy may be further utilised. Messrs. Merryweather's pump is well suited for garden work, as it is only necessary to fix it by a pond or fountain and attach a suction and delivery pipe, when the little engine will project the water in the usual manner.

The Crystal Palace Electrical Exhibition.—The special committee appointed by the Electrical Section of the London Chamber of Commerce to co-operate with the directors of the Crystal Palace Company in promoting the success of the exhibition, consists of the following gentlemen: Mr. R. E. Crompton, M.I.C.E. (chairman), Major S. Flood Page and Mr. Emile Garcke (vice-chairmen), Mr. J. E. H. Gordon, B.A., M.I.C.E., Mr. G. Binswanger, and Mr. Alexander Siemens, M.I.C.E.

Blackpool.—On the recommendation of the General Purposes Committee of the Blackpool Town Council, it was resolved the Mayor, and Councillors Buckley, Heap, Sergenson, Kingsbury, Leigh, Pearson, and Ward be appointed an Electric Lighting Order Committee, to consider and recommend to the Council what action the Corporation should take under the Blackpool Electric Lighting Order, 1890, with authority to obtain a report on the subject from an electrical engineer to be chosen by the committee.

Automatic Brush-Shifter.—The principle of shifting the brushes to suit the load, used on the Thomson-Houston machine, seems to be likely to be adopted for Brush machines (at any rate, on the other side) if there be anything in signs. Mr. Thos. E. Adams, of the Brush Company, Cleveland, has devised a set of double differential magnets coupled by rods direct to the brushes, whose action tends to shift the brushes of a series arc machine according to the change of load. A sliding weight counteracts the frictional drag of the commutator on the brushes.

Eastbourne.—The borough surveyor of Eastbourne reported at the last Council meeting that he had received a letter from the Eastbourne Electric Light Company stating the charges on the proposed new contracts would be 10d. instead of 1s. per unit, a reduction of 17 per cent. The gas company have granted a further reduction of 7½ per cent. The borough surveyor presented an exhaustive report on the comparative costs of gas, oil, and electricity. It was resolved that in view of the reductions made by the gas company the Council do not make any change in the public lighting.

Waterford.—At a special meeting of the Town Council the following resolution was adopted: "That pursuant to the provisions of the Electric Lighting Acts of 1882 and 1888, we, the Mayor, Aldermen, and Burgesses, hereby resolve to apply to the Board of Trade for a license to supply electricity for public and private lighting purposes, within the borough of Waterford, and an area outside said borough, not exceeding five miles, same to be computed from the General Post Office, and that the Lighting Committee be requested to enquire as to the proper method of obtaining the license, and report to the next meeting of the Council."

Automatic Car Stopper.—An ingenious contrivance for stopping a vehicle when the horse runs away has recently been patented by a German inventor, and is now to be seen in working order at the German Exhibition. It may be possibly applicable to electric trams. By means of a lever working under the feet of the driver, a self-acting spring brake is set in motion, effectually stopping the vehicle. The mechanism is extremely simple, and yet it is guaranteed to work successfully. The harness in the case of a horse carriage can also be made to detach itself instantaneously, and thus free the horse without danger to the driver or the vehicle.

Electricity v. Oil in Burmah.—After many experiments with the different varieties of mineral oil lamps, several millowners in Rangoon have, according to *Indian Engineering*, ultimately introduced electric lighting apparatus on their premises. Messrs. Bulloch Bros. and Messrs. Mohr Bros. have recently fitted installations at their mills at Kemmendine and Poozoundong respectively, and the Burmah Oil Company have just completed fitting up their yards with the electric light. A comparative statement of the two systems—electric and oil lamps—although showing a larger first cost for electric lighting plant, shows that it is cheaper after a time, and possessing numerous and other advantages over oil lamps.

Edison's Latest.—Edison is busy writing a romance of the twentieth century, showing forth the great part that electricity is to play in the coming years. The story, it is stated, is being written in conjunction with Mr. G. P. Lathrop, a well-known writer in America, and husband of one of Nathaniel Hawthorne's daughters. Edison will write the electricity and Lathrop the necessary love story. The motto for the future generation will evidently be, "'Tis love, 'tis love (and electricity) that makes the world go round." The idea is certainly capable of considerable expansion. Bellamy tried it in his famous didactic story, not altogether, perhaps, with the utmost success attainable to an expert. Electricity certainly seems to promise to take possession of the next century, and in the application of inventions to romance Edison ought to be *facile princeps.*

Torquay.—At the meeting of the Torquay Local Board on Friday last, Mr. Briscoe Hooper, their legal adviser, pointed out that the Board were in possession of a provisional order, under which they had powers to light the town by electricity, the estimated cost of the installation being £10,000. There was an Electric Light Committee in existence, and one of the first matters they would have to consider was whether they would advise the Board to carry out the order. If so, there was thus £10,000 to be obtained. He reported this in order that the town might know that the Board had these powers, which the Act gave them two years to carry out. Mr. Harrison said he intended to propose that the Bath Saloons should be lighted at once by electricity. They could do this almost without any cost, and it would be a good experiment. The matter was referred to the committee.

Bath Electric Light Company.—A statutory meeting of this company was held on Saturday. The chairman explained that originally there were only five directors, but the board had been strengthened by three London electricians—one gentleman from the Brush Company, one from the Callender Company, and one from the firm of Messrs. Laing, Wharton, and Down, all of whom were large shareholders. Of the 3,500 shares offered, 3,241 had been subscribed. Mr. Titley stated that with the present plant they could supply three or four times the amount of electricity. General Jervois said the directors had been giving their attention to the reduction of cost. They hoped to induce people outside the present area of supply to have the light brought into their houses from motors which could be set up in the outhouses. The capital is practically fully subscribed. The meeting closed with a vote of thanks to the chairman.

Whitehaven.—The Whitehaven Town and Harbour Trust are ready to discuss and adopt electricity, as their contract with the gas company expires this month. The Trustees have obtained a provisional order to light their district by electricity, and it is open to them to contract or to light for themselves as they may think fit. The water power at Ennerdale was suggested but thought too small, and the two engines at the sewage works were also spoken of. The chairman proposed that application be made to ascertain the most suitable way to light the town and harbour for 12 months or longer. The motion was carried. The proposals are to be sent to the secretary, who will lay them before the Harbour Committee and the Streets Committee. Other water power than Ennerdale, with greater force, might be obtained; the whole question being one for the careful consideration of the Trustees.

Electric Lighting Company for Leeds.—Recently the Leeds County Council determined to let the electric lighting of the borough to the Yorkshire House-to-House Electricity Company, Limited. Up to the present no move has been made by the company. This is due to many Leeds gentlemen being away on their holidays, and it is impossible at this time to form a local company. At the end of the month, however, steps will be taken to float a company composed of Leeds gentlemen. If this is not practicable, people in other parts of England will be allowed to take shares. When this is arranged, the work will be commenced. Hollow iron tubes are being erected on the Roundhay road, some 30 yards apart, to carry the overhead wires for the electric tramway. Other wires are laid in the ground between the rails. The depôt, near Beckett-street, is rapidly progressing. It is suggested that a large new Board school in Roundhay-road, which is approaching completion, should be lighted by electricity.

Accident in a Paris Central Station.—A tragic accident is thus related by the *Daily News* Paris correspondent: "While the audience were sitting at a performance at the Opera Comique, in Paris, the other night, all the lights went out, and the same thing occurred at the same moment at the neighbouring Châtelet Theatre. Naturally a good deal of surprise and some little alarm were felt, but the darkness was only temporary. At the end of about 20 minutes the little horseshoe lights began to glow again, and the performances at the two houses were proceeded with as though nothing had happened. Meanwhile the police were removing to the Morgue the remains of a poor fellow, the engineer at the establishment from which the electric current is supplied to the two houses. The audience did not learn until after their night's amusement was over that he had been accidentally killed, and that it was his mangled body in the machinery which, interrupting the current, had caused the lights to go out in so unexpected a fashion."

Southend Pier.—The following information with reference to the Southend Pier electric railway, which has been kindly furnished by Mr. Thos. Baines, engineer-in-charge for Messrs. Crompton and Co., Limited, will doubtless prove interesting to electrical engineers and municipal authorities, as it speaks well for the popularity of the electric railway. The tram line since its start has done exceedingly well, and no trouble has been experienced with the line or cars in any way. During the month of July the passengers numbered 57,621, which at 2d. per head comes to £480; this is besides luggage. During the month of August the number of passengers was 86,040, or £717. These results from a small local line up and down a pier are encouraging. It will be remembered that this tram was fitted up electrically last season by Messrs. Crompton and Co., under the supervision of their London manager, Mr. W. A. Chamen. The Crompton dynamo is driven by a Davey-Paxman engine, and the continued good working of the line testifies to the care and excellence of the workmanship.

Electrical Transmission.—In a very carefully thought-out paper, dealing with the minimum cost of plant and maintenance in power transmission, in the N.Y. *Electrical Engineer*, Mr. H. Ward Leonard makes some severe attacks on present formulæ, notably by F. J. Sprague and on Sir Wm. Thomson's famous "interest and cost of copper" law. This law, which Sir Wm. Thomson first enunciated in a paper on "The Economy of Metal Conductors of Electricity," before the British Association in 1881, was given as follows: "The most economical area of conductor will be that for which the annual interest on capital equals the annual cost of energy wasted." This law has been widely accepted, says Mr. Leonard, but on close and practical investigation proves entirely incorrect as applied to maximum economy of an installation, for the surprising reason that no account whatever is taken of the fact that the cost of the engine and dynamo per horse-power transmitted will vary as the loss in the line varies. Consequently the correct minimum and that obtained from Thomson's law are often widely different.

Dundee.—The monthly meeting of the Gas Commission of the Dundee Corporation was held on Wednesday, Sept. 2, Lord Provost Mathewson presiding, when the committee appointed to examine the various systems of electric lighting in other towns similar to Dundee submitted its report. It stated that the committee had visited Bradford, Deptford, Chelsea, and St. Pancras, and that if the Gas Commissioners resolved to supply the light they should adopt the low-pressure continuous-current system, with a station as near the centre to their compulsory area as possible. As regarded the cost it was difficult to get reliable information, but that the cost to the consumer would be considerably over that of gas might be reasonably counted on. In view of the great progress which had been made within the last few years, not only in regard to cost of production, but in many improvements for economical distribution, the committee were hopeful that in a short time an installation in Dundee, if properly gone about, might become at least self-supporting. The commissioners agreed to hold a special meeting to consider the subject.

Burton.—At the last meeting of the Burton Town Council it was stated that tenders had been received for lighting the town by electricity, but the selection had been deferred. Alderman Lowe said the examination of the tenders, which varied considerably, for the electric lighting of the town would occupy a great amount of time, and that the committee were therefore precluded from reporting upon them at that meeting. They hoped, however, to be able to deal with the matter at the next meeting. Councillor Rugg enquired as to the time that was likely to elapse before electricity would be introduced into the borough. Alderman Lowe replied that Mr. Ramsden had just informed him that he did not think it would be provided for use in the town before the winter of 1892. Up to the present the enquiries for the light had been very few indeed. The Council might rest assured that they would be well within the statutory time, and, if there appeared to be any need for it, they would gladly press forward its introduction. Councillor Rugg thought they were trying to "put off the evil day," and said that several tradesmen were negotiating for their own installations.

Canterbury.—A proposal was before the Canterbury Town Council last week "That the offer of the Brush Electrical Engineering Company to take over the Canterbury Electric Lighting Order, on the terms of their letter, be accepted." The terms were that the company were prepared to undertake the formation of a local company to take over the provisional order which the Corporation had obtained, and to refund to the Corporation the cost of the order, which was understood to be about £200, as soon as the necessary capital had been raised. As an earnest they would deposit 10 per cent. of the cost of the order at once, to be forfeited if the company be not formed, and the total consideration for the order paid within three months from the date of acceptance of the proposal by the Corporation. Alderman Mount explained the proposal, and moved its adoption. Mr. Dean opposed it, and proposed it be not accepted. The town clerk suggested that a committee be appointed to confer with the Brush Company as to terms, and report to the Council. Alderman Mount agreed to this course on the understanding that immediate steps were to be taken, and a committee was accordingly appointed.

Harwich.—A special meeting of the Harwich Town Council was held last week to confirm a resolution passed at the last Council meeting, instructing the town clerk to make an application to the Board of Trade for a license to supply electricity under the Electric Lighting Act, for all public and private purposes within the area of the borough of Harwich. The town clerk, in answer to a question, said the cost of the order would be about £150. Mr. Rose said the Council could specify terms if they obtained a provisional order. They could then ask for tenders to light the town, and retain the option of supplying private persons, the limit of time being 42 years. After obtaining the order there would be no difficulty in getting a company to supply public and private consumers, and he believed that if they adopted the policy of lighting the town by electricity they would have no cause to regret it. Mr. Norman seconded the proposition of Mr. Rose. Mr. Hill moved as an amendment that the proposition be deferred for three months. He thought the plant would cost £7,000 and the maintenance £15 a week. Mr. Everard pointed out that Mr. Hill's amendment meant delaying the matter another 12 months. Mr. Rose said that Mr. Hill seemed to be the only objector. If this proposition were carried and an order obtained, the Council would not be bound to put down Messrs. Crompton's plant, but they would get tenders from other firms. The proposal to obtain an order was carried by a large majority.

Heilmann's Combination Engine.—Our readers will remember that some months ago we gave the outline of a proposal of M. Heilmann, late chief engineer to the Société Alsacienne des Constructions Mécaniques, for the introduction of a new principle in railway practice. It is well known to engineers that the difficulties in getting higher speeds on railways lie chiefly, if not entirely, first, in the difficulty in getting rid of the steam from the quick-moving parts, and secondly, especially on ascending grades, of the need of greater adhesion between engine and metals. Both of these M. Heilmann proposes to obviate at one stroke, by having his engine, a triple-expansion comparatively slow-speed engine, coupled direct to a dynamo, the dynamo to supply sufficiently high-speed motors attached to the axles of every carriage, thus driving each carriage separately. The engine proposed is of 600 h.p., the dynamos and motors of the Rechniewski type. A speed of 50 miles an hour on gradients of 1 in 200 is looked for, and a speed of 70 to 80 miles an hour on the level. M. Heilmann has recently formed a syndicate with a capital of 300,000f. to work out the invention, and it is stated that the authorities of the French railways have accorded permission for experiments to be tried upon their lines. The profits of the syndicate, when made, are to be divided as follows: 10 per cent. to the directors, 45 per cent. to M. Heilmann, and 45 per cent. to the shareholders.

Prizes Offered.—The Société Industrielle of Amiens has offered for the season 1891-2 a number of prizes, consisting of money, and gold and silver medals. These are for answers to questions, amongst which several are with reference to electrical or kindred subjects. If a subject is not completely solved a portion of the prize may be awarded. 1. A gold medal for a brake dynamometer capable of replacing the Prony brake, with more convenient apparatus than the latter. 2. A gold medal for a simple and cheap dynamometer capable of measuring the work absorbed by a tool or machine driven by belt or gearing. 5. A gold medal for a water purifier for steam boilers—simple, cheap, taking little space, and requiring little supervision. 6. A gold medal for the best electric light installation working in an industrial establishment, and costing less than gas, taking works of 300 to 500 burners, making its own gas. 23. A gold medal for a chemical application of electricity in the district. 24. A gold medal for important improvement in the bleaching of wool or silk. 25. A gold medal for the best treatise on the bleaching of hemp and jute, comprising a theoretical study and the examination of the various methods employed in practice. Further, a gold medal of 200f. value will be awarded to all papers that merit this prize—in arts or mechanics, in spinning, in natural history, physics, chemistry, or agriculture; and in commerce and political economy. Manuscripts must be sent, prepaid, to the President, de la Société Industrielle, rue de Noyon 29, Amiens, by the 30th April, 1892.

Queenstown.—At the monthly meeting of the Queenstown Town Commissioners on Monday, Mr. Doran proposed the motion that advertisements be issued inviting tenders, to be under £300 a year, for the electric lighting of the town for five years from June 30th, 1892, the candle-power not to be under 20,000. He said that the town of Carlow was 17 acres greater in area than Queenstown, and the electric light there was eleven times more powerful than the present lighting of Queenstown, and the cost was only £170, whereas in Queenstown they were paying £474. In Carlow the electric light cost the ratepayers 2d. in the pound, whereas Queenstown was at present paying 6d. in the pound. He had fixed a limit at £300, and if the tender amounted to the fixture it would save the town £144, which would be a saving of 3d. in the pound. Mr. Farrell moved that the matter be adjourned for two months, and that the clerk be instructed to write to the town clerks of Carlow and other towns lighted by electricity to get particulars of the cost of lighting, and its working. Mr. Fitzgerald was not in favour of the Commissioners pledging the rates of the town to the extent of £300. If any company liked to come and make the experiment he would be the last to oppose it. Mr. Doran said that on account of the statement made by Major Curry at a previous meeting that the electric light in Carlow had been unsatisfactory, he had written to the town clerk of Carlow, and he had replied that the arc lamps at present there had been most successful, but the incandescent lamps had not yet been put up. The amendment was carried by four votes to two, and the town clerk will therefore require particulars of various systems.

Wertz Arc Lamp.—Abolish the commutator of your dynamo, and abolish the mechanism in your arc lamp, and you will have an ideal system of public lighting. Some attempts, more or less successful, have been made towards the abolition of commutators, and alternating dynamos are practical without commutators. The other requirement—an arc lamp without mechanism—if not nearer solution, has at all events been tried and tested. M. Xavier Wertz, of New York, is credited with the solution of this problem, and has produced a combination arc and incandescent lamp which may develop into a successful article. The carbons are placed in an exhausted glass globe, and burn so slowly that no feeding is required, the lamp simply being entirely replaced when burnt out. The construction of the Wertz lamp is as follows: A short, thick, hollow carbon is taken, connected to a conductor, and inserted in a globe. The second carbon passes inside the first, having a solid core and round head, which rests upon the cylindrical carbon. The space between is filled with an insulating layer of asbestos, which prevents any current passing except at the upper surface of the cylindrical carbon, where the two carbons touch. At this point of contact an arc is formed of sufficient size to produce a light of considerable power. The lamp is intended for high-tension series working, and may be fitted with a cut-out and used on ordinary arc lamp circuits. It is possible that we have here the 200-c.p. simple arc lamp that has been sought for. No details are given of its luminous efficiency as regards an ordinary arc lamp. The saving of first cost and attendance, however, might well pay for increased cost of current in many circumstances.

Electric Ventilators for Steamships.—The Commission of Plant and Machinery for the French Minister of Marine has just contracted for the supply from the Société L'Eclairage Electrique of seven electric ventilators on board the steamship "Le Magenta." The ventilators will be fixed under the ironclad bridge, and the whole will be covered in with an outlet communicating with the system of distribution. The disposition of the ventilating plant was required to be easily maintained and taken apart, and each piece is to be as light a weight as possible. The fans are mounted direct on the shaft of the electric motor. Special precautions have been taken to prevent the oil from coming in contact with the insulated wires, and oil ducts are arranged for the escape of used oil. As these ventilators will be required to run continuously for long periods, every arrangement has been made to prevent the various parts of the motor from overheating. The interior coils of the motor have been so arranged as to give at will two different speeds by the simple movement of a commutator, the normal speed being 1,200 revolutions. The lower speed is 600 to 900 revolutions, the alteration taking place without addition to the exterior resistance to the motor circuit. The following are the general details: Pressure, 70 volts; current, 18 to 20 amperes; revolutions, 1,200; pressure of air in height of column of water, 2 cm.; diameter of disc, ·64 metre (22½in.); total weight, 616lb. In the Government test the ventilator was placed in a wooden box, whose dimensions reproduced the space left free in the "Magenta." The opening was reduced to an outlet of 6 decimetres square. The ventilator, with 70 volts at the terminals, and a current of not over 20 amperes, was found to maintain a pressure of 2 cm. of water, corresponding to an output of 4,000 cubic metres an hour. These tests were carried out to the entire satisfaction of the commission.

Electricity in Mining.—At the annual meeting of the National Association of Colliery Managers at Newcastle on Friday, Mr. Henry Palmer, of East Howle Colliery, Ferryhill, the president, alluded in his address to one subject which is growing daily in interest and importance, and one which will soon force itself upon his notice—electricity. "It is true," said Mr. Palmer, "that some of us have ventured to employ this new and mysterious agent in a few cases, and I am proud to think that our association counts as a distinguished member one who has been a veritable pioneer in the application of electricity to mining, and more particularly in the way of underground pumping. To Mr. Frank Brain I owe a deep debt of gratitude for assistance freely given. There are at the present time several small electrical pumping plants at work in the county of Durham, and at East Howle we are pumping 1,000 gallons per minute in that manner. It is also being introduced in the North for hauling and other purposes. I advise colliery managers to begin to accustom themselves to the new agent, and to make themselves familiar with the rules relating to the measurement of an electric current. The necessary solution of many unsolved problems in mining lies with you, gentlemen, and I have every confidence that whether absolute scientific and practical rules can be established or not to satisfy the ever-varying conditions of mining, the consideration of such subjects may be safely left with you, and I am content that the results will in the future, as in the past, be received by the mining world as steps towards the higher social, scientific, and intellectual position of colliery managers, and a simplification of the manifold duties they are called upon to perform."

Closed-Conduit System.—An interesting exhibit at the Frankfort Exhibition is a novel and simple closed-conduit system of electric traction by Messrs. Schuckert and Co., of Nürnberg. The closed conduit systems hitherto tested in practice in this country comprise two kinds—that advocated by Mr. Lineff, in which a continuous conductor laid underground is drawn up into communication with the conductor sections, one after the other as the car proceeds, by the attraction of a magnet placed on the car; the other, advocated by Mr. J. Gordon, charges the conductor sections by a return insulated circuit actuated by magnets placed not in the car, but in a box under the pavement. Schuckert's system is of the first order, based upon the Lineff principle; but instead of using a continuous thin strip of iron which is raised magnetically to make contact, Messrs. Schuckert employ iron filings, in the following simple expedient. The conductor sections are laid along in the roadway upon solid wood planks, bedded in the ground, under which is the main strip conductor. Each wooden plank is pierced downwards at intervals along its length by taper holes of 1¼in. to 2in. diameter, which have the smaller diameter at the top. Before laying the iron conductor rails over the planks, these holes are each partly filled with a handful of iron filings, which drop down upon the main conductor. As the tram passes, its magnet energises the roadway beneath it, and the iron filings rise in a heap and make contact with the surface conductor, falling again as the car passes. The taper form of the hole prevents their continued contact after the car passes, and the number of holes and the mass of filings is said to obviate all difficulty with reference to contact or sparking. The car was not working when we had the pleasure of visiting the Frankfort Exhibition, and we cannot, therefore, state from experience whether the project is practicable. It was, however, stated to work well on the experimental line.

PENDANT FITTINGS FOR SHIP LIGHTING.

The enclosed sketches show an improved form of pendant, designed by Mr. Malcolm Sutherland, electrical engineer to Messrs. Wm. Denny and Bros., Dumbarton. Fig. 1 shows the complete fitting. B B is the back block made of teak boiled in paraffin, to which the brass junction-box, J B, is attached. The wires are led in through water-tight stuffing-boxes, and attached to the screwed junction, J. The stalk of the lamp, S, is then screwed into its place, making contact with the junction J. Then the ornamental cover, O C, is screwed hard up against the wood, jamming the stalk and preventing it from getting loose. To prevent the cover from slacking back, two screws are driven through the flange into the wood. G C is the usual Edison-Swan globe carrier. Fig. 2 shows the upper and lower ends of the stalk, S. J B C is the junction-box cover which is permanently attached to the stalk. C is a rod of brass, which forms the lead, the return being the stalk and junction-box. W is the insulating material, being also formed of hard wood boiled in paraffin. The upper end of this is tapered to prevent moisture from lying across the top and causing a short circuit. A spring plunger is attached here to ensure good contact. To prevent the possibility of an arc being formed, in the event of the fitting getting loose, the plunger is made so long that the fitting must fall clear of the box before it breaks contact. In the old form a central contact lamp was screwed into a nipple on the lower end of the stalk. In the new form the wood is carried right down into the lamp carrier, L C, and another spring plunger is attached. By this arrangement we have only two joints instead of three. A small tapered shoulder is turned on the wood, which, being jammed between the end of the stalk and the nipple, N, prevents it from changing its position. This form of pendant is now being used by Messrs. Denny for ship lighting.

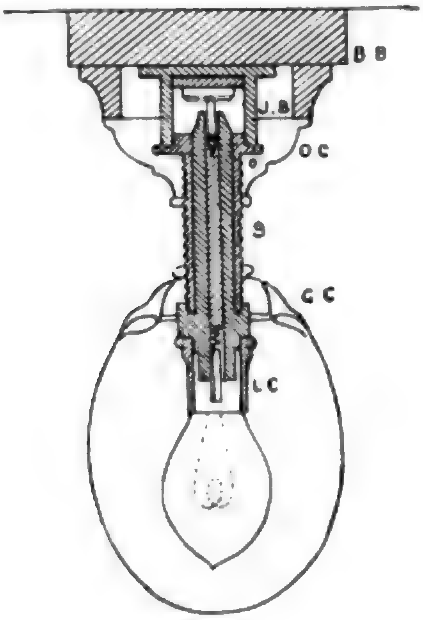

Fig. 1.

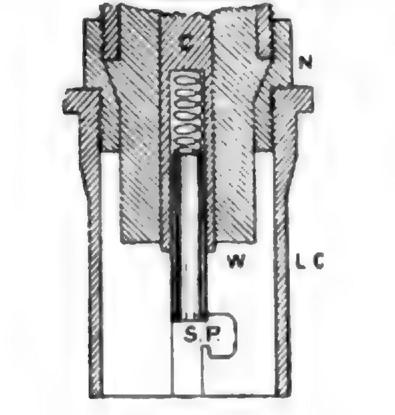

Fig. 2.

PRIORITY IN ALTERNATING-CURRENT MOTORS.

The question of priority in the discovery of the alternating-current motor would seem to need definite settlement, both on account of historical accuracy and the avoidance of acrimonious discussion. It has been usual, in Europe, to ascribe to Prof. Ferraris the priority in the demonstration of the possibility of rotary motion being obtained from alternating currents, and in a recent *résumé* of the subject M. Hospitalier so accorded the credit. The dispute, so far as fundamental principles are concerned, is limited to Prof. Ferraris and Mr. Nikola Tesla; and the New York *Electrical Engineer* this week vigorously asserts the priority for America in the person of Mr. Tesla.

The following are the words of our contemporary: "Prof. Ferraris has been credited with the discovery now in controversy on the strength of his admirable paper, read before an Italian scientific society, in March, 1888, and published in Italian shortly afterwards. But five months before this, in October, 1887, Mr. Tesla had already filed applications for patents embodying the discovery, and several months before that time had so far perfected his invention that a company had been formed to exploit it. Many prominent persons, including several electricians, then saw the Tesla motors at work; and during the winter of 1887-8 one of the best-known scientific men in this country (America) examined and reported favourably upon them. Some time in April, one of the present editors of the New York *Electrical Engineer*, knowing of this new work, saw the motors which had then been running for some time in a temporary laboratory, and induced Mr. Tesla to bring his discovery before the May annual meeting of the American Institute of Electrical Engineers. The motors were actually shown in New York before a large gathering.

"On May 1, 1888—the same year—patents were issued to Mr. Tesla in America as the result of his application in October, and were then accessible at once in every European country. But the work of Prof. Ferraris was not brought to light in English-speaking countries (and others, too, for that matter) until it was given prominence by the publication of it in *Industries*, May 18, 1888. That interesting article was freely copied, as it well deserved, and its publication in this wise created the false idea that Prof. Ferraris's striking work was simultaneous with that of Mr. Tesla, or even prior. But the description of the Tesla invention must have evidently been made public on the patent, in England and other countries, before the date of the *Industries* article, and besides the fact of the issue of the patents there is the fact that a contemporary, the New York *Electrical Review*, had given a short illustrated description of the Tesla motors on May 12.

"More than this, in his essay of March, 1888, Prof. Ferraris expressly denied the practicability of motors that Mr. Tesla already had in successful operation! He hinted at the possibility of using a proper generator for such motors, but no further did he go. Mr. Tesla had already taken coal out of the mine before Prof. Ferraris had made his geological survey of the region. With this admission from Prof. Ferraris, it was not very likely that practical men would recognise the great value of the new principle.

"On examination of Mr. Tesla's now familiar work, we find that he, on the contrary, had not stopped short at a mere rotating field, but dealt broadly with the shifting of the resultant attraction of the magnets; that he had evolved the multiphase system; that he had shown the broad idea of motors employing currents of differing phase in the armature with direct currents in the field; that he had shown both synchronising and torque motors;

that he had shown how machines of ordinary construction might be adapted to his system, and had with specific purpose advanced boldly into new territory, of which there was not the slightest hint or suggestion in the work of Prof. Ferraris. In other words, Mr. Tesla not only went to the bottom of the fundamental principles, but tried them in every detail that inventive ingenuity could hit upon. If this is not so, it is time to have the contrary state of affairs proved before Mr. Tesla loses the credit that such work must give him."

THE LIGHTING OF RAILWAY TRAINS ELECTRICALLY.[*]

BY J. A. TIMMIS.

It is not advisable here to enter on any lengthened dissertation as to the relative merits of oil or gas or electricity as a means of lighting, as such, to be complete, would involve many intricate side issues connected with the expense of first cost, and the attendant and complex ones of maintenance and labour.

There can, however, be no doubt, and we may take it as generally admitted, that the light from oil lamps is not sufficient to supply the wants of the travelling public.

The light given by the most approved system of gas lighting is undoubtedly far superior to that supplied by oil lamps, but it is not equal to that given by high candle-power incandescent electric lamps.

The test which must be applied to any system of train lighting is a light equal to daylight on a fairly clear day—in other words, a light sufficient to enable anyone to read at night with the same ease and comfort that he can when travelling in broad daylight. This is self-evident on reflecting that at most stations papers are sold, and that the sale of papers, periodicals, and books on railways has grown into an enormous trade.

Our experience after hard and anxious work, spreading over four years, gained from the lighting of some 300 carriages, most of them long bogie cars, is, that while it is perfectly easy to light any carriage or any train successfully, and to give absolute and constant satisfaction to the railway authorities and also to the travelling public, it is a matter (now that it is attained) of imperative necessity to give a system which is not extravagant in first cost, and is (and this is of far greater importance) economical in labour and renewals—*i.e.*, in working and maintenance.

We may lay it down as a law to begin with, that, in order to obtain the greatest efficiency and economy, a whole railway system must be lighted and not merely a portion of it.

But as it is most improbable that any large railway company would light the whole of its stock at once, it is an evident advantage to have a system which enables the stock to be fitted gradually.

Having stated these primary conditions, we will consider a number of other conditions which we find are imperative in detail.

1. Each and every carriage must carry its own store or reservoir of electricity, because it may be attached to any train throughout the system, and then may be taken off or slipped from the train it is travelling with and attached to another (or the same) train at any important station, and while detached the carriage, if lighted, must remain so. In addition to this—(*a*) The weight of the electric battery in each vehicle must be small, on account of weight and expense. (*b*) The batteries must not be liable to be charged when the carriages are in regular work, neither must any carriage be detained at any point to have its battery charged. Every carriage must be free to be used in traffic always.

2. In order to give such an amount of light (as mentioned above) as shall be equal to daylight—(*a*) The lamps used should be 16 c.p. (*b*) The voltage used to drive them should be as high as practicable, because the consumption of electricity (a most important factor) is materially reduced. We find that 50 volts is the safest limit. The carbons of lamps of over 50 volts will not stand railway travelling. (*c*) The reflectors should have a convex and diffusive shape.

3. The light must be under the control of the guard.

There are three methods by which electricity may be generated for the lighting of railway carriages.

1st. By a dynamo driven from an axle of the train, and this is sometimes necessary, but never advisable. A dynamo must be driven from the axle in the case of a Waggon-Lite train, because this company does not own or work the locomotives, neither do they possess any rights in the railway stations. In addition to these conditions, the speeds of their trains are uniform and the distances between stoppages are very great, so that the conditions are not only special but as favourable for axle driving as they can be. In Russia, also, the very long runs and the low and uniform speed of trains, added to the difficulty of fixing a dynamo and engine on the locomotive, make it sometimes advisable to use axle-driven dynamos. But under ordinary circumstances, axle-driven dynamos are most objectionable, because—(1) The field magnets have to be larger in proportion in order to deal with the increase of speed between that at which the dynamo cuts in to charge the batteries and the maximum speed of the train. This is sometimes as 1 to 3. (2) The gearing is very soon worn and destroyed. (3) A special set of skilled workmen have to be employed in order to keep them in order. (4) Practically, every van would have to be fitted with a dynamo, and also with a large battery. The expense entailed being beyond all reason, as, if there is a dynamo on the train, there should not be any electric battery to light the main lamps.

2nd. Another method is to drive a dynamo on the train by a special engine, using locomotive steam (in special cases we have used a special boiler in a very large van; but the circumstances were exceptional, and the objections to its general use are so obvious that it is not necessary to mention it further).

3rd. The third method for the generation of electricity is to employ a plant at certain important stations to light the stations and yards, and at the same time to charge the batteries used in lighting the trains.

These two latter systems each have their advantages.

With a dynamo and special engine on the locomotive—(1) Which are self-contained, and which only vary less than 1 per cent. in speed, with a variation of up to 50 per cent. in steam pressure—*i.e.*, which are constant in speed and also in electrical efficiency. (2) Which are not over 3ft. 6in. high by 4ft. by 2ft. (3) Which start automatically when steam is turned on. (4) Which are boxed in from dust and wet, and do not heat. (5) Which do not require lubrication for several days when in constant work. (6) The locomotive driver has very little extra work and no attention to give to this. And we have obtained all these points.

It is clear that the generation of electricity for lighting trains becomes simple and economical, especially when (*a*) the high voltage necessary to run the lamps efficiently and economically can be readily obtained. (*b*) A main battery is not necessary by our system. (*c*) As will be seen hereafter the total weight of batteries on a train of 12 long bogie cars is only about one ton.

On the other hand, if the main lighting is effected by main batteries in the vans, and they are charged at central stations by large plants which also light the stations, the following economies are effected: (*a*) A few large plants serve to generate the electricity required to light all the trains on a railway system, and also to light the stations instead of a large number of small ones. (*b*) A few skilled men only are required. (*c*) The deterioration of large plants is much less than in the case of dynamos on the trains. (*d*) The efficiency and economy of large plants is proportionately greater.

We come now to the point where it is necessary to describe the arrangements which we find most suitable and economical for carrying out the above conditions, and getting over all difficulties.

We fit the carriages with 16-c.p. 50-volt lamps, and we light these lamps either with a special engine and dynamo on the train, or with a battery consisting of 26 accumulator cells placed in the guard's van. These lamps, which we call the main lighting lamps, consume ·6 of an ampere each, whereas a 32-volt lamp consumes over an ampere. This is a very great advantage and economy in the working of railways. The extra number of cells—viz., 26, as against 18—being far more than counterbalanced by the saving of nearly 50 per cent. of electricity (*i.e.*, cost of charging and weight of lead per cell), and the increased amount of light.

But as each carriage has to carry its own storage of electricity for the reasons stated above, and as it is not practicable to put 26 (or even 18) cells in each vehicle, because of (*a*) the weight; (*b*) the first cost and maintenance; (*c*) the difficulty to charge them with a dynamo on the train, and impossible to do so with central charging stations, we have worked out and patented all over the world—even in Germany and the United States our claims have been fully allowed—the following arrangement, our main object being to minimise the weight and cost of electric batteries.

In addition to the main lighting we place small voltage lamps (eight volts we find sufficient) in the carriages, and a small four-cell accumulator battery in each carriage to light them. The leads and couplers and switches will be described presently.

These small lamps may be separate from the main lamps, but we have patented and are regularly using lamps with two filaments in. These lamps are shown in Messrs. Edison and Swan's catalogues and in the drawings herewith. They are so arranged that as soon as a pair of couplers are separated they are automatically lighted in the carriages that are separated from the main circuit, by the small batteries. They are also under the control of the guard.

The small batteries are very light (weighing per carriage less than 1cwt.), they are not costly, and they are kept charged by the engine and dynamo or the main battery in the guard's van as required. Thus every carriage is free to be used in any train, and the only batteries that require special arrangements for charging, if any, are those in the guard's van.

In order to effect the charging of these at central stations, we designed, some three years since, special light trucks, with the top flat platform adjustable as regards its height, and sufficiently large to hold two complete main batteries.

One of these trucks takes a freshly charged battery at a charging station to a guard's van, receives the battery from the van, and the fresh one is put into its place. The contacts are made automatically.

It must be remembered that the only times the auxiliary lamps are used are when a vehicle is taken off a train and perhaps put, for a few minutes at the longest, into a siding and then joined on to another train, or when a vehicle is slipped from a train and while it is brought to a stop at a station, and during this time the auxiliary batteries give 6 c.p. to 8 c.p. in each auxiliary lamp.

In the case of division of a train, for instance, where a long train of some 20 or more coaches splits up into, say, three divisions, then each division has at least one guard's van, and so it is, electrically and otherwise, if main batteries are used, a complete train; and if special engines and dynamos are used, the lighting is equally complete.

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[*] Paper read before the British Association.

Having described the main conditions which we find necessary to fulfil, and the general mode of dealing with those conditions, so as to give an economical and efficient system for lighting railway trains, we will describe the drawings and diagrams in order to make the details of working the two last systems clear.

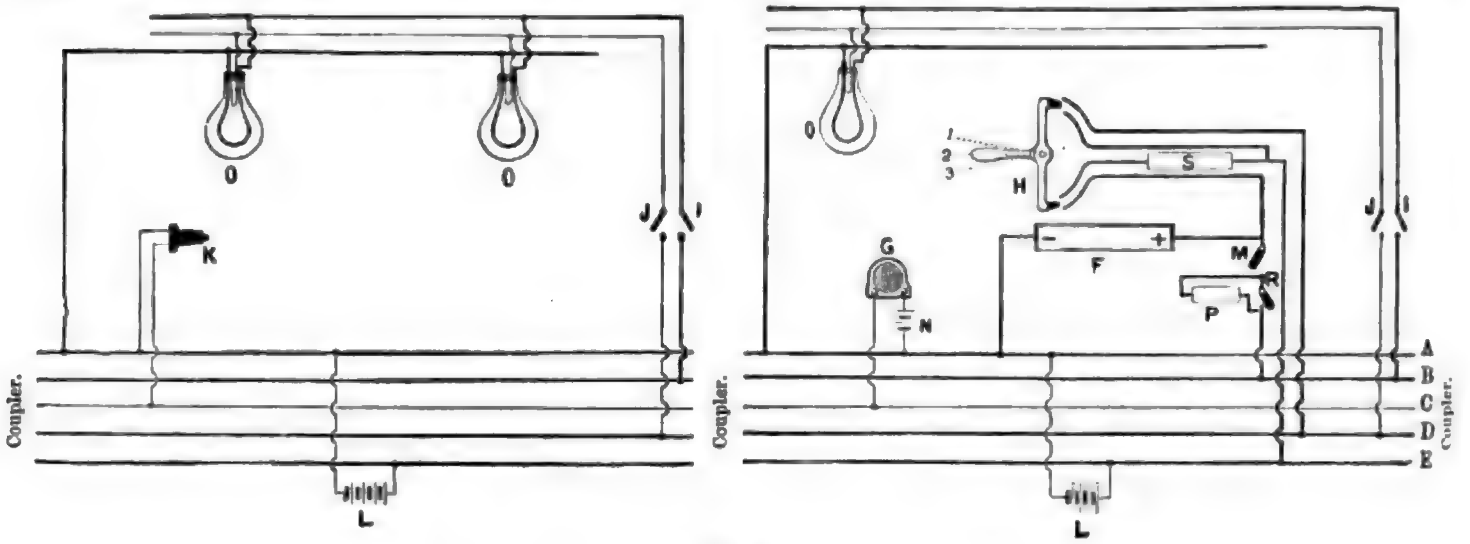


FIG. 1.

There are two diagrams. First, the larger one, explaining the "four-wire" system. The five leads, A, B, C, D, E, run throughout the whole length of the train and are joined up from carriage to carriage by the couplers. A is the main negative. B is the main positive from the large battery, F, or from the dynamo with its special engine. C is the communication positive wire. D is auxiliary lamp main lead, and E is auxiliary battery main lead. It is evident that if D and E are joined, the auxiliary lamps will light up, provided the local switches, J J, are closed. F is the main battery of 52 volts. G, communication bell. H, auxiliary battery three-position switch. J J, auxiliary lamps local switches. I I, main lamps local switches. K, communication push. L L, auxiliary batteries (it is possible to do without the auxiliary battery in van). M, main lighting switch. N, bell battery. O O, main lamps with auxiliary filaments (the auxiliary lamps may be separate from the main lamp). Before describing the action of the system, I may say that safety fuses are fitted in every carriage, but these have not been shown in the figure in order not to complicate it.

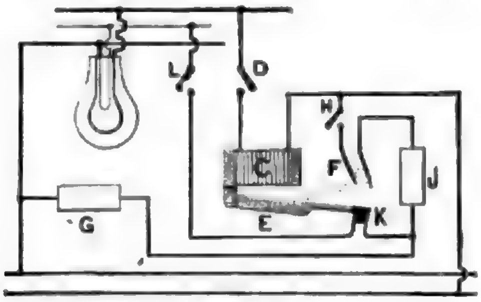


FIG. 2.

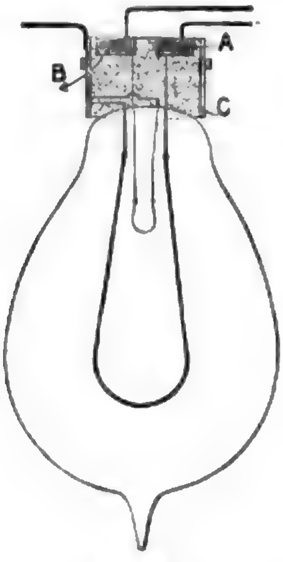


FIG. 3.

As will be seen from Fig. 1, when the train is coupled up the whole of the main lamps are lit from the battery, F, which is switched on to the circuit by a switch, M (in combination with a switch, R, and resistance, P, to equalise the discharge). There is also a local switch, I, in each carriage which governs the lights in each individual carriage without interfering with the rest of the train. The same action takes place if there is a dynamo on the locomotive instead of a main battery.

The charging of the auxiliary batteries is effected from the main battery or from the dynamo on the locomotive as follows: The switch H is placed in position 3, and the current flows through S to all the small batteries in the train in parallel, the resistance, S, being adjustable to the number of batteries in the train. When H is in position 1, the auxiliary lamps are lit from the auxiliary batteries. This is necessary, for example, in the case of changing the main battery at a station. The small batteries can, of course, be charged in series if it be found desirable.

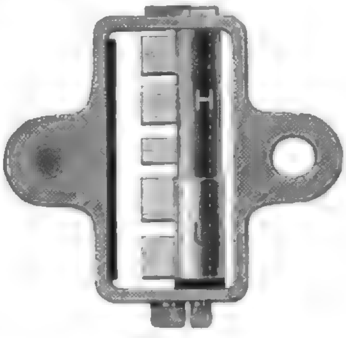
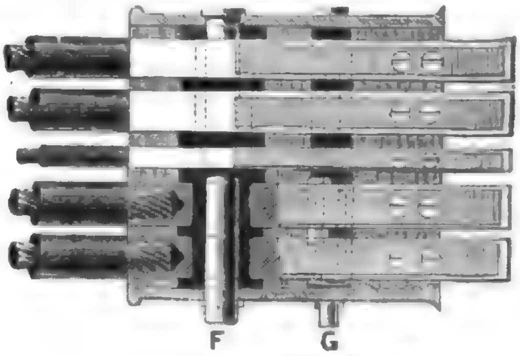


FIG. 4.

FIG. 6.



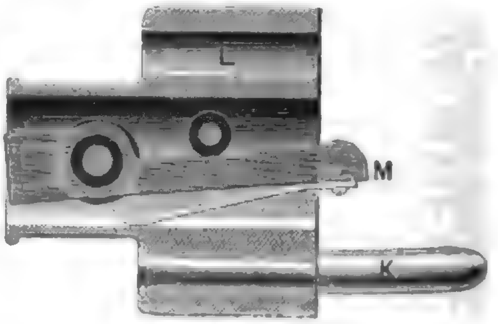


FIG. 5.

The communication system, with its push, K, in each carriage or compartment, its main lead, C, bell, G, and small battery, N, is self-evident and needs no explanation. It may be worked by the main battery if desired.

The action of the automatic coupler strips, D E, is as follows: Should the train be parted anywhere, the strips D E, in the couplers that are severed, come down to the piece J, Fig. 4, and the lead D, Fig. 1, is thus connected to lead E, and the current thus flows from the auxiliary batteries to the auxiliary lamps. When the train is once more coupled up, the connection is broken at the piece J, Fig. 4, and the main lighting leads then come into action, and the auxiliary lamps go out.

The smaller diagram, Fig. 2, represents the working of the same systems by the use of two through leads instead of four. This we consider equally efficient and more economical.

The main lighting current from main + B passes round coil C, and, when switch D is closed, lights the large lamps or filaments, and in passing round C, it actuates armature, E, raising it and making contact, F, and holding it there during the whole time main lamps are lit. The auxiliary battery, G, is thus placed in communication with main + by means of the switch H, which, when closed, charges the auxiliary battery through the resistance, J.

When the main lighting circuit is broken in any way, the current in C is also broken, and the armature, F, falls and makes contact, K, and the auxiliary switch, L, being closed the auxiliary lamps light up. When the main lamps are once more lit the auxiliary lamps are automatically put out by the action of E.

In the double-filament lamps, Fig. 3, the large + is connected to piece A, the small + to piece B, while the brass casing, C, forms the common negative to both filaments, and this casing makes contact with the lampholder which is attached to the general negative main.

Fig. 4 shows cross-section of the coupler for the four-wire system ; Fig. 5 the longitudinal section ; and Fig. 6 the sectional plan. The five strips correspond, and are attached to the five leads, A, B, C, D, E, respectively, shown on main diagram, Fig. 1.

The strips are all pivoted on the pin F, and are all insulated from it and from each other by the insulation shown in black. The pin G carries upon it the insulating piece, H, upon which the three strips A, B, C rest when the couplers are detached, and it also carries the brass piece, J, which is itself insulated from the pin G. The object of the piece, J, is to automatically connect the two strips D and E when the couplers are separated, and thus light up the auxiliary lamps, as shown on diagram of general arrangement. The pin, K, entering the hole, L, of the corresponding coupler, ensures the accurate meeting of the various strips and prevents short-circuiting. As the couplers are pressed together, the curved ends of the strips engage with each other and hold the couplers together. The springs, M, keep the strips in connection with their corresponding strips, or with the piece J when advisable. If the two-wire system is used, only two strips are necessary.

In conclusion, we would remark that we can only claim as absolutely new in principle (as apart from the details of couplers and double-filament lamps and other mechanical matters) the combination of a main lighting circuit with high E.M.F. and efficient economy, together with an auxiliary lighting circuit and lamps with small batteries and economy in weight, cost, and maintenance.

DISCUSSION.

Mr. Killingworth Hedges thought that the subject of train lighting was one of great importance. It was to be regretted that Mr. Timmis's paper did not come on earlier in the day, when more attention could have been given to it. With the main conditions laid down by Mr. Timmis, particularly the one which stated that every carriage ought to carry its own store of electricity, he cordially agreed ; in fact, he had advocated the same plan three years ago at the British Association meeting at Manchester. He must say, however, that it had been rather difficult to convince the railway authorities that they must, in order to break up their trains, put a battery in each carriage. It appeared to him that the main circuit and the auxiliary circuit when connected must be a very complicated system, and, indeed, one that would be difficult to arrange unless rolling-stock were joined together. He could not see the good of the auxiliary circuit, because if they lighted with batteries connected up in a carriage, why not put in batteries of small capacity, perhaps, three or four hours' storage, and work them from the dynamo, which in ordinary times when the train is in motion lights the whole installation. The auxiliary limits of lower candle-power would offer grave objections, because people would sooner do without the electric light than have it suddenly lowered. In his (the speaker's) paper at Manchester, he mentioned batteries having zinc and lead electrodes. Since then little had been done with them, but the other day, when seeing Mr. Webb, of the North-Western, he was told that they were acting extremely well, experimentally. If such cells were used they might obviate the difficulty complained of by Mr. Timmis in ordinary secondary batteries. At any rate, he thought it would be quite practicable to put a set of batteries either of zinc and lead or the ordinary batteries in a carriage, and get sufficient capacity to attempt all the lighting during ordinary stoppages at stations. One great objection to heavy batteries was the liability to be broken. When travelling on the Midland the other day, where a good system of electric light was used, he found the electric light was not at work. Upon asking the reason, he found that the train at one of the stations ran into the station buffers with sufficient force to knock the batteries out of the case and break it, and the orders were, that until it was put together again, not to use the dynamo. On the Midland they had tried successfully a very important experiment, and that was one advocated at the British Association by Mr. Preece ; it was known as Mr. Barber-Starkey's plan, and consisted of filling up cells with plaster of Paris and making them quite solid, and he was told that it acted admirably. In conclusion, the speaker expressed confidence in the fact that electricity must very soon be the illuminant used for trains, and pointed out the disastrous consequences of a collision between trains lighted by gas.

Mr. Bennett referred to a system of lighting used on the North British Railway.

Mr. Smith, in replying for Mr. Timmis, said, in reference to Mr. Hedges's objection to heavy batteries, it was that very reason which impelled Mr. Timmis to put small batteries in each carriage. Mr. Hedges did not quite see that was that system—no dynamo was used. If there was a large battery, then there was no small one. It amounted to this, that if they had a charging station where they lighted the railway station, one used the same plant to charge the big battery in the guard's van. If the big battery was employed to light the main lights, then only little batteries were required to light the auxiliary lights. These could be left in the carriages from one month to another, with only occasional supervision, because they were charged from the big battery. As to the diminution of light it was not so serious as Mr. Hedges supposed. The reduction was from 16 c.p. to 10 c.p., which was quite good enough to read by. This, however, only occurred in stations, and it was supposed that the diminution of light here would not be very noticeable—at least, it would form no serious inconvenience.

ON THE ELECTRIFICATION OF STEEL NEEDLE-POINTS IN AIR.*

BY A. P. CHATTOCK.

(Concluded from page 203.)

Although the silent discharge from a point does not appear to have the power of permanently clearing away surface-resistance, sparks do so readily enough—though under suitable circumstances they will also form it again. In making the measurements on needle B (Table I.), the discharge at the last recorded (+) reading took the form of a spark. $\sqrt{P}$ was here 1·59. On repeating the reading it had risen to 1·95. A third discharge brought it back to 1·62, and after that it continued to oscillate between these two values for some 20 or 30 times with hardly a break in the regularity. Obviously one spark formed a resistance and the next blew it away again. The character of the sparks was quite different, too. The one which formed the resistance was thin and sharply defined, and spread out for a considerable distance over the plate like a splash. The other was much brighter, straight, and without any signs of a defined edge.

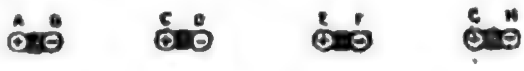
While, however, the above is evidence of the existence of surface-resistance at used points, the fact that the values of f at beginning and end of discharge are practically identical for a clean point for both positive and negative electricity, may be regarded as showing that such resistance is either very small or non-existent on points which have not been used before.

Atomic Charge

§ 6. Assuming, then, provisionally that cohesion in Grotthuss chains is the sole cause of the resistance offered to discharge at a clean point, and that gas atoms are consequently concerned in carrying the electricity when it does so,† there arises the interesting question as to the amount of charge carried by each atom ; and one is tempted to see whether the above measurements throw any light on it. Without in any way pretending to settle the point, the following considerations seem to me to render it probable that the electro-chemical equivalent of gas atoms is of the same order of magnitude as that of the same atoms in electrolytes.

The essence of a Grotthuss chain is that it shall consist of molecules capable of being split into two parts, one of which is charged after the split with positive electricity and the other with negative. These charges may exist separately in the molecules to start with, or they may be induced by an electrostatic field—but in either case it is the field which subsequently arranges them in chains ; and the breaking down of the chains occurs when the mechanical pull of the field on the charged parts is sufficient to overcome their mutual affinity. This affinity may be due to one of two causes or their combinations. Either it is (*a*) the electrical attraction of two initial charges, or it is (*b*) a cohesive attraction without any previously existing charges, or it is (*c*) both. One of these three it must be, if by cohesive attraction is understood the sum of all non-electrical forces between the two parts of the molecule.

Consider the first (*a*) of these cases. If the molecules hold together by internal charges, they may be represented thus in their free state :



the lines in between the pairs of atoms signifying lines of electrostatic force. A chain of such molecules will give way when it is put in a field of force just strong enough to redistribute the charges by induction, so that half as many lines pass between A and B, C and D, etc., as before, and the remainder pass between

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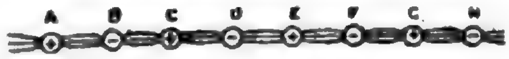
* Paper read before the British Association.

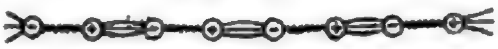
† This does not preclude the possibility of metal dust in the discharge after it has once started.

B and C, D and E, etc. This state of things may be represented thus:



Put in another way, the strength of the field which will do this is rather greater than that which would induce on each of the two end atoms of the chain half their assumed initial charges, supposing them to be connected by a fine conducting wire. It depends thus on the length of the chain being greater as the chain is shorter.

In the case (*b*), a constant cohesive affinity between the two parts of the molecule, it is necessary to suppose that electricity can pass from one to the other under the influence of induction when they are put in a field of force, in order that after separation they may be oppositely charged. The following figure shows



a chain of such molecules on the point of breaking down, the break occurring when the cohesive forces (⁓⁓⁓⁓) are just overcome by the electrical forces (═══) set up by the field. Here, again, the longer the chain the weaker the field required to break it; and as the cohesive forces are constant, and the electrical forces are dependent, for given molecular arrangement, only on the charges induced in the molecules, it follows that these charges will also be practically constant, no matter what the length of the chain may be.

In both these cases, therefore, for all lengths of chain, the atomic charges at the breaking point are constant; in case (*b*) being rather less than such as would be induced by the field on the end atoms, supposing the latter to be connected by a conductor; and in case (*a*) less than twice that amount (less because the chain is not a continuous conductor). Their values might thus be calculated in terms of f if the geometrical conditions were known. This, however, is not the case under the conditions of actual experiment; but by arranging that the chains shall consist of single molecules only, it is possible to get an idea of the magnitude of the charge in question. Reduce in imagination the discharging point to molecular dimensions; and find, by what is rather violent extrapolation, the corresponding value of f at discharge from the constant in Table II. The Gretthuss chains will have been reduced to single molecules by the reduction of the point, and by supposing them to be spheres the + and − charges induced on their opposite sides may be calculated. These charges will then represent in the case of (*a*) half, and in the case of (*b*) the whole of the atomic charge.

Taking the diameter of a molecule as $\frac{1}{2} \times 10^{-8}$ centimetres, the value of f at the centre of a molecule opposite the point is (from Table II.)

$$f = \frac{16{\cdot}5}{4} \times \left(\frac{1}{4}10^{-8}\right)^{-0{\cdot}8} = 3{\cdot}1 \times 10^{7} \text{ E.S. units.}$$

which will induce on a conducting sphere of the same dimensions equal and opposite charges of

$$\frac{3}{4}\left(\frac{1}{2}\,10^{-8}\right)^{2} f = 6 \times 10^{-10} \text{ E.S. units,}$$

This number is greater than the atomic charge (or than half the atomic charge) because it is calculated from measurements on chains of many molecules, which, as was pointed out above, are not conductors, but only lines of high S.I.C. Now the most probable value of the ionic charge of oxygen is 10^{-11}, which, considering the extent of the extrapolation and the fact that the above number is too great, is in sufficiently strking agreement with it. It is at any rate satisfactory that the experimental number is the larger of the two.

It is interesting to see whether a similar result is to be got from measurements of sparks between plates. Taking Dr. Liebig's numbers above referred to, I find, following Prof. J. J. Thomson, that the formula $f = \frac{a}{l} + 150$ expresses the results for the smallest spark-lengths in air fairly well, considering that the numbers for that part of the curve are rather irregular. The values of a lie between 1·9 and 1·4 for the five smallest spark-lengths ($l = 0{\cdot}0066$ to $0{\cdot}0245$ centimetres. Extrapolating for a distance between the plates of $\frac{1}{2} \times 10^{-8}$, the field between them comes to be 4×10^{6}. This would induce a still higher charge (8×10^{-9}) on a spherical molecule; but it must be remembered that these data are much further removed from molecular dimensions than mine.

On the other hand, there is a case accessible of what may perhaps be called discharge between plates, which takes place actually within molecular dimensions: I mean the passage of electricity at the cathode of a voltameter. Here, if a step of potential of, say, one volt be assumed, and if f stand for the corresponding field between the liquid and the metal of the cathode,

$$f \times \frac{1}{2}10^{-8} = \frac{1}{300}, \text{ or } f = \frac{2}{3}10^{6} \text{ E.S. units.}$$

This is capable of inducing on a spherical molecule charges of $1{\cdot}5 \times 10^{-11}$ E.S., a number which cannot be distinguished from the ionic charge. Moreover, no reduction is necessary here as the data of calculation are from measurements made direct on single molecules.

Taking, then, these three calculations together, and having regard to the fact that the nearer the conditions of experiment approach molecular arrangement the closer are the results to the value of the ionic charge, I cannot help thinking that they furnish strong grounds for supposing that electrified atoms in gases are associated with the same quantity of electricity as in electrolysis.

As regards the third possibility of molecular cohesion (*c*) mentioned above, that it is due to a combination of (*a*) and (*b*), it is impossible, without knowing the relative values of the two forces at work, to get any idea of the atomic charge from the value of f. All that can be said is that it will be less than the value calculated for atoms held together by electrical attraction only. Even in this case, therefore, there is nothing to negative the presence of ionic charges in gaseous conduction.

Effect of Pressure.

§ 7. If the conclusions arrived at above be correct, one may picture a metal point on the verge of discharging as a smooth curved conducting surface studded all over with Grotthuss chains standing up on it like bristles. The density of charge upon it will thus be far from uniform. It will reach a maximum at the root of each chain, the quantity collected there being constant for a given gas, independent of the length of the chain, and equal perhaps to the ionic charge of the gas atoms. In between the chains the density will be much less.

Now the field, f, measured by the attraction of a plate on a needle-point is the average number of lines of force per square centimetre of the point-surface, and takes no account of the manner in which they are distributed over it. This is because the point is so small that the lines have room to become uniformly spread out before they reach the plate. Hence it follows that, for different dispositions of the chains, the measured values of f may be very different, and yet the number of lines of force running through each chain be the constant number corresponding to ionic charge on its atoms; f, in fact, for a given amount of induction per chain, depends both on the length and on the closeness of the chains. Great length, or great closeness, or both, means that the greater part of the lines proceeding from the point have been absorbed by the chains, hardly any passing in between them. In this case f is practically proportional to the number of chains per square centimetre, and is independent of their lengths. On the other hand, very short chains, or very few to the square centimetre, or both, means that f is sensibly independent of their closeness, but is now dependent on their length, being inversely proportional thereto so long as it is not very great compared with the radius of curvature of the point. In between these two extremes f depends both on length and on closeness of the chains, varying in an inverse manner with the former, and in a direct manner with the latter.

Now, both length and closeness of the chains increase with increase of gas pressure; hence, there must be some pressure, A, above which f is sensibly proportional to the closeness of the chains only, and some lower pressure, B, below which it is inversely proportional to the chain-lengths only. In the neighbourhood of A increase of pressure will affect f chiefly by the resulting alteration of the closeness, and will therefore increase f. Near B it will have the opposite effect, as increase in the length of the chains means a decrease of f. Hence between A and B there must be some pressure for which f is a minimum. This point is, of course, well known to exist,* though I was unable to obtain a sufficiently good vacuum with my apparatus to reach it. If, however, f be expressed in terms of some power (n) of the pressure, n will be 0 at the minimum point, and positive and increasing as the pressure rises from there. This increase is shown well in Table III. (calculated from Table II. for positive discharge only—the negative is too uncertain). Here n_1 is calculated from the values of f, corresponding to 76 and 40 centimetres of mercury, and n_2 for 40 and 20 centimetres; n_2 is in every case less than n_1.

TABLE III.

Needle.	r.	n_1.	n_2.
C	$0{\cdot}7 \times 10^{-3}$	0·31	0·20
D	1·6 ,,	0·42	0·36
E	1·88 ,,	0·39	0·34
F	4·03 ,,	0·48	0·35
G	4·84 ,,	0·48	0·44
H	6·52 ,,	0·50	0·39
I	7·11 ,,	0·53	0·42
J	7·83 ,,	0·49	0·38
K	8·71 ,,	0·52	0·40
L	10·9 ,,	0·52	0·46
M	31·8 ,,	0·61	0·58
N	45·7 ,,	0·69	0·61
O	58·0 ,,	0·69	0·56
X	400·0 ,,	[0·80]	0·72

The needle marked X was in reality a steel ball used for bicycle bearings. This was put opposite a tin disc of 6 centimetres diameter at a distance of 3·6 centimetres. n was calculated from measurements of the difference of potential between ball and plate, as f could not be measured. The values of n fit in well with the rest. (n_1 was calculated in this case from f at 40 and 60 centimetres mercury.)

Now pressure alters the length and closeness of the chains at the same time; but, for a given field strength at a point-surface, alteration in curvature gives rise to alteration of chain-length only, the length being less as the point gets sharper. Hence at a sharp point f is more dependent on the length of the chains than at a blunt one; it is, in fact, nearer its minimum value, and n is consequently less. This, too, is shown very clearly in Table III.

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* Rontgen, Weidemann's Electricitat, vol. iv., § 582.

A pretty illustration of the influence of point curvature on n was accidentally met with in the case of needle C. In getting it into the apparatus for repetition of the curves obtained with it, its point came against the metal box, and was flattened slightly to a width of about $3·6 \times 10^{-3}$ centimetres. Tho values of n_1 and n_2 obtained from it after this were respectively 0·42 and 0·30, instead of 0·31 and 0·2 for the finer point.

Grotthuss chains, coupled with constant atomic charge, are thus well able to explain most of the phenomena described in this paper. There still remains one which is perhaps the most important of all—the difference in the behaviour of positive and negative discharge. This I hope to discuss in connection with experiments now in progress, but it may perhaps be well to place on record the results so far obtained.

TABLE IV.

	r.	k.
C	$0·7 \times 10^{-3}$	1·36
D	1·6 "	1·42
F	4·03 "	1·40
G	4·84 "	1·26
H	6·52 "	1·28
I	7·11 "	1·23
J	7·83 "	1·24
K	8·71 "	1·32
L	10·9 "	1·13
M	31·8 "	1·08
N	45·7 "	0·94
O	58·0 "	0·94
X	400·0 "	0·83

These are given in Table IV., where k is the ratio at a pressure of 20 centimetres of f for positive discharge to f for the negative. The ratio shows a distinct tendency to decrease as r increases. It is almost useless to give values at higher pressures on account of the uncertainty as to the condition of the point, and the great effect this may have on the negative discharge (Curves III.); but the ratio is distinctly less at higher pressures, for points which seemed quite clean; the decrease of k at 70 centimetres mercury varying from 3 to 8 per cent. as compared with k at 20 centimetres. For dirty points the decrease may reach 50 per cent.

Description of Apparatus.

§ 8. The electrometer used for potential measurements was constructed on the principle of the one designed some years ago for absolute measurement of much smaller quantities by Prof. Minchin. The attracted disc is suspended, and the force of attraction measured by tilting the whole instrument until the disc falls back by its weight to a fixed point. The disc is a sheet of mica, covered on one side with tinfoil and metallically connected with the case of the instrument, which is a tin cylindrical box 30 centimetres long by 30 centimetres diameter. The disc hangs just outside a 3in. hole in a tin screen at one end of the case, and opposite the hole inside the case is an adjustable disc of tin which forms the attracting plate. The sensitiveness of the instrument may be varied very greatly by altering the distance between this plate and the suspended disc. This arrangement does not of course permit of absolute measurement, but it was thought that calibration in terms of spark-lengths was sufficiently accurate for the work in hand.

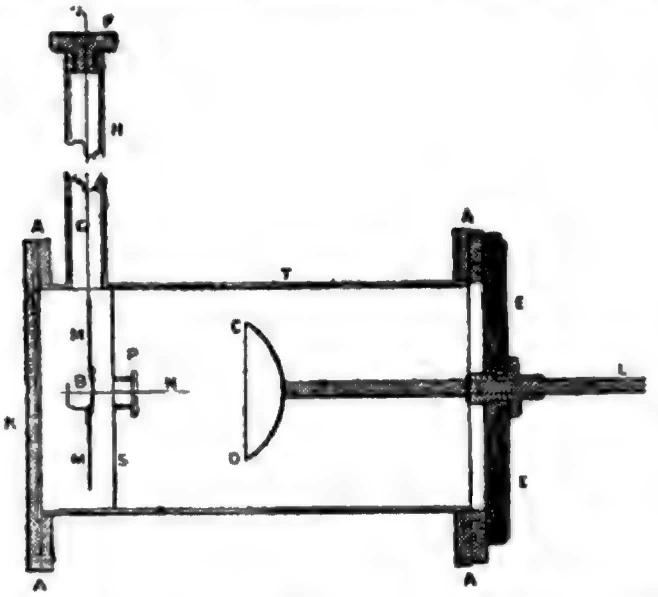

FIG. 1.—T, brass tube forming body of instrument; length 10 centimetres, diameter 6 centimetres.
H, tube for suspension wire, G. F, ebonite plug.
M, mica disc suspended from G, carrying light metal clip B, holding needle N.
S, tin screen soldered into T.
K, metal cover. E, ebonite cover.
A A, ground air-tight joints, greased.
C D, spherical metal cup to be electrified; C D = 3·35 centimetre, radius of curvature = 1·76 centimetre.
P, short brass tube on S; length = 0·5 centimetre, diameter = 1·2 centimetre.
Point of N at centre of curvature of C D. Length of needle projecting beyond P = 2 centimetres.

The same principle of tilting was used in measuring the attractions on the needle-points; the needle in this case taking the place of the suspended disc. The zero position was determined by a hair in the eye-piece of a microscope through which the point of the needle was observed; the latter being at the centre of curvature of C D, Fig. 1, when it coincided with the hair. The needle was illuminated by small windows in T (not shown). L was connected to the Wimshurst; T to earth; and G—*i.e.*, N—through a high-resistance galvanometer to earth, the indications of the galvanometer being therefore due only to current discharged from N. A much larger instrument, constructed on the same lines, was used for needle A and other measurements. The body of this instrument is a tin cylinder, 43 centimetres long (horizontally) and 23 centimetres in diameter. The needle is suspended in a small metal box at the centre, and the electrified plate is supported like C D, Fig. 1, from one end.

The tilting is effected in each of the above instruments by fixing them to a brass base, provided with pivots at one end and a vertical micrometer-screw with large divided head at the other. The method works admirably.

In conclusion, I wish to express my thanks to my friend Mr. F. B. Fawcett, a former student of University College, Bristol, and to my assistant Mr. J. Quick, for much careful help in carrying out the measurements described in this paper. To Prof. Lodge my thanks are so numerous that I cannot express them. His kindness, both by word and by deed, has been unceasing. Indeed but for him this paper would probably never have been written.

Results.

1. Point-discharge depends only on the strength of field close to the point between pressures of 76 and 10 centimetres.
2. Field here measured absolutely by its pull on the point.
3. Seat of resistance to discharge shown to be in gas only, for a clean point (Grotthuss chain).
4. Atomic charge, probably of same order of magnitude as ionic charge.
5. Effects of pressure and of point-surface curvature in accordance with Grotthuss chains.

PORTSMOUTH.

Mr. Shoolbred suggests in his report to the Portsmouth Town Council the low-tension system for private lighting with storage batteries, and the three-wire system for distribution, using armour-protected cables, laid underground, and embedded without any other covering whatever. The capacity of the electrical installation which he recommends to be laid down at first would be of a maximum output of 5,000 lights each of 16 c.p., burning at one time. This figure of 5,000 lights would mean a total of about 8,000 lights connected with the system of distribution. The buildings at the generating station should, however, be constructed large enough to contain without addition generating plant for about double the electrical output above mentioned, so as to allow for reasonable extension of the first supply. The boilers preferred are of the Lancashire type, steel and double-flued, working at 180lb. pressure per square inch. He recommends that steam engines of the inverted vertical type, running at moderate speeds, driving the dynamo direct, and placed in the same bed-plate therewith, be adopted. The sizes of steam engines which he recommends are those capable of developing 150 i.h.p. and 75 i.h.p. respectively. Should sea water for condensing purposes be not readily available (and it is not at present in central Portsmouth) the engines should be one of the compound non-condensing type.

The capital expenditure for this part of the scheme is put at £45,000, and the revenue at £10,390, with a profit calculated to reach £1,451. We do not agree with Mr. Shoolbred's estimates—£10,390, with a maximum even of 8,000 lights wired, is rather more than we should expect, but as a rule the maximum number of lights estimated for are not wired for some years. For the public lighting Mr. Shoolbred suggests arc lights, the figures for which are: Cost of 25 lights on the Clarence Esplanade, 25 on the South Parade, with engines, dynamos, boilers, cables, lamps, and posts, etc., £5,500; 40 arc lights at refuges and other prominent points in streets named in the electric lighting order, with engines, dynamos, etc., £5,000; contingencies, 10 per cent., £1,050; making a total of £11,550.

The committee, having considered the general question of the electric lighting of Portsmouth, and inspected the systems in vogue elsewhere, stated they were of opinion that the scheme furnished by Mr. Shoolbred was the best that could be adopted. They had come to the conclusion, after exhaustive enquiry, that the low-pressure system was the most suitable, by reason of its absolute safety and economy in working. A further advantage of this system was that it could be utilised for motive power. In Mr. Shoolbred's report the total cost of the installations for public and private lighting was estimated at £56,550; but to this should be added a sum for acquiring a site and meeting other expenses. The committee recommended that Mr. Shoolbred's report be adopted, and that application be made to the Local Government Board for sanction to borrow £60,000 for the purposes of the electric lighting of the borough.

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IS THE ELECTRIC LIGHT A FAILURE?

Such is the title of an article, describing an interview with Mr. W. H. Massey, which appeared in the *Oracle* of September 5th. It is not often one looks to professed financial papers for well-considered opinions upon any subject. The lucubrations given therein are too often biassed and intended to influence market operations. The *Oracle*, however, can hardly be classed as a purely financial paper; in fact, it seems a kind of olla podrida, touching upon art and sport as fluently as it touches upon finance. Its "interviews" are generally well done, and record opinions of experts upon the question of the moment. Last week the *Times* article upon the progress of electric lighting in London, and Mr. Massey's comment thereon, evidently struck the note which led to the interview. Our opinion upon certain points put forward by the *Times*, and commented upon by Messrs. Massey and Crompton, as expressed in our last issue, seems to meet the general view. The past is historical. Nothing that can be said or done now will alter it. Let bygones be bygones, but take care for the present and the future. The *Oracle* interviewer does not bring out so clearly as he might the emphatic answer to his title question. The electric light is not a failure, but many of the professed advocates of the electric light are not only failures—they are fools. They imagine any tale, be it as far-fetched as that of Sinbad the Sailor, may advantageously be used to induce people to patronise electricity. One of the most foolish, one of the most stupid arguments ever introduced, was the comparison of the cost of gas and of electricity. Mr. Massey, during the interview referred to, is reported to have said: "It is suicidal in my view for people to say that they can supply electricity at anything like the price of gas. It was because people said that that the maximum charge settled by Parliament was fixed too low. . . It is such a good light, both from the point of view of illumination and sanitation, that there is no reason why it should be pitted against gas." Mr. Massey's views relating to companies' profits and to patents are well worthy of consideration, but we think he is rather hard upon the companies. It may be agreed that at present a sufficient time has not elapsed to prove the accuracy of their accounts, to determine exactly what should and what should not be charged to capital. Far too much is usually put to capital account by managers of most companies. However, there is more depending upon the policy of the supply companies for commercial success than upon the question of accounts. Mr. Massey says, and this appears the crux of the whole matter, "I myself think that these public supply stations would have a much better chance of success if they were to go in by day for the supply of power, and by night for the supply of light. But in the early years of their existence they should in any case charge a sufficiently high price to pay their way." The general public will accept Mr. Massey's criticisms as by far the most valuable that have appeared, in that he is totally unconnected with any firm or any supply company. He is known also as a very blunt exponent of his carefully arrived at conclusions. In all new departures the public has to be educated by interested parties, which renders it necessary that as occasion requires the more sensational statements should be toned down somewhat by those who view the question more dispassionately. If those interested in supply companies will take as much trouble to educate possible customers to use power as well as light they will certainly make their paths, paths of greater pleasantness, and bring about that happy time when their machinery can be used to the greatest advantage—when they can obtain the greatest output at the least cost per unit, and hence when the commercial value of electrical apparatus can be fully exploited.

STILL THE B. A.

Mr. Walker's criticisms of the British Association are in some cases a little too severe. Surely it cannot be expected that the evening lectures, for example, should partake of the character of scientific "pap." It serves to show how very varied are the opinions regarding the association's work, for a goodly number of critics have looked upon these evening lectures as *the* redeeming feature at each successive meeting. As to Prof. Rücker's lecture this year, we think that the general consensus of opinion is altogether favourable. Commencing with simple optical knowledge, gradually, as it were, link by link extending the width of knowledge, experimentally showing step by step the similarity of optical and electrical phenomena, Prof. Rücker carried his audience through the whole lecture without verbal redundancy or aught but the simplest language, so clearly delivered that no one starting with the flimsiest fundamental notions could fail to follow all that was said and to comprehend the beauty of the analogies experimentally brought forward. We should never fear for the future of an association that depended for preservation upon such lectures. There would be no falling off in numbers nor in interest—rather the contrary. Prof. Rücker's lecture was worth going to Cardiff and becoming a member of the association in order to hear. Those who attend these lectures are expected to have obtained a sufficient groundwork of scientific knowledge upon which the lecturer can build. They should not be learners in the sense of starting with absolute ignorance of the subject, but should be learners in the sense of having the necessary fundamental knowledge to follow the lecturer into some special path in which few have previously trod, and which till then is more or less hidden from the multitude.

We have no objection to criticise freely the sectional arrangements, or the monetary arrangements, but we could not, if we would, find one word of fault or of disparagement to a lecture such as that of Prof. Rucker's. A condemnation may be too sweeping to be effective, and we imagine Mr. Walker will after further consideration agree that the British Association cannot be expected to ask its lecturers to confine themselves to elementary subjects solely to benefit those still in the wilderness, nor, again, must it be expected that the presidential address be such as to be understanded of the multitude. This address is either a record of general progress, of progress in some one science, or the epitomised work of a lifetime. Few have trod the whole path delineated, and the address marks at the moment the uttermost point which has been reached. History starts afresh from this point, and so the record grows. Who would have it otherwise?

HELMHOLTZ'S BIRTHDAY.

On August 31 Prof. Helmholtz celebrated his seventieth birthday at Madonna de Campiglio, where he is spending the holidays.

Campiglio is an old monastery converted into an hotel, and stands at a height of 6,000ft. in the mountains of the Austrian Tyrol. It is accessible by a 13 hours' drive from Trient on the one side, and by a mule track over the Mendola Pass on the other, and commands views of the Bocca di Brenta and other famous mountains. There is no village, and the hotel stands miles from any other habitation.

Prof. Helmholtz is accompanied by Madame Helmholtz, by his sister (Baroness Schmidt Zabirow) and her husband (his Excellency Baron Schmidt Zabirow), and by his daughter (Mrs. Werner Siemens) and her husband (Mr. Werner Siemens, jun.)

At an early hour an illuminated address of congratulation, prepared by Herr Josef Hofer, the well-known Munich artist, who is also staying at Campiglio, and signed by all the visitors, was presented, and subsequently the visitors called on Prof. and Madame Helmholtz to offer their congratulations. Prof. Helmholtz's rooms were profusely decorated with flowers. Among those who called were Prince and Princess Molfetta, Prof. Dr. von Bayer (the well-known chemist), La Duchesse di Melzi, and her daughter, the Comtesse di Melzi, Herr Josef Hofer (Munich), Herr von Dechy (Budapest), Herr von Gündel (Hamburg), Mr. and Mrs. J. E. H. Gordon (London), Canon and Mrs. Harvey (Lincoln), Mr. and Mrs. Jennett Brown (Meran).

Later in the day a dinner was given to Prof. Helmholtz, when his health was drunk with great enthusiasm, while the peasants' band played under the windows. Prof. Helmholtz is in the best of health and spirits, and looks nearer 60 than 70.

CORRESPONDENCE.

"One man's word is no man's word
Justice needs that both be heard."

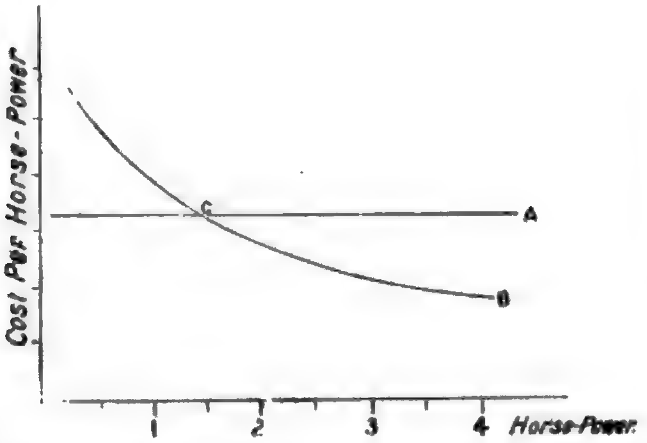
THE WEYMERSCH BATTERY.

SIR,—While thanking you for your kind notice of our battery, may I point out one inaccuracy which might possibly be misleading. You say "the battery gives a steady current of 20 amperes at 20 volts for 20 hours, the cost being given by the syndicate as just over a shilling per unit." Now, the cost per unit will necessarily fluctuate with the price of zinc, and of the materials necessary for producing the depolarising fluid. But at the present price of the above articles the cost per unit is between 1s. 5d. and

1s. 6d. Should the price of zinc fall to what it was a few years ago, this, coupled with the fact that as the demand for depolarising solution becomes greater it is possible to make it more cheaply, would cause the cost per unit to fall to the figure named in your article.

I have troubled you with this perhaps unnecessary explanation because so many primary batteries, which promised marvellous things, and have enjoyed but an ephemeral existence, have come before the public, that it is wise to state that the Weymersch Syndicate do not claim to compare the burning of zinc as fuel with the burning of coal on the basis of cost only, and do not wish to claim extravagant advantages for the use of their primary battery in directions which are manifestly outside the legitimate scope of such an apparatus.

If I am not trespassing at too great a length on your valuable space, I might just call attention to the following diagram which may be taken to illustrate the field open to a good primary battery. Taking everything into account—viz., absence of all risks, of explosions, absence of moving machinery, and simplicity in manipulation (no technical skill being necessary)—line A may be taken to represent the cost per horse-power of energy generated by the "chemical" engine, so to speak, while curve B may be taken to represent the cost when generated by a steam, gas, or petroleum motor. The cost per horse-power from the primary cannot vary very much for small or large powers, while the efficiency of a steam engine increases with the size and power of the engine. Assume that A and B intersect at about C, then it may be considered that for electric light installations of about 20 8-c.p. lamps it is less trouble to use the primary battery than a steam or gas engine and dynamo, but that beyond this the difference in cost becomes considerable. Speaking generally, it may be taken that where not more than 1 h.p. to 1½ h.p. is required it is worth while to produce this by means of the primary battery, more especially if the installation is to be left in the hands of non-technical attendants.



It is, of course, needless to add that the battery can be used for a variety of purposes other than the production of electric light.—Yours, etc., ED. C. DE SEGUNDO,

Executive Engineer, The Weymersch Electric Battery Syndicate, Limited.

London, S.W., Sept. 5.

MISSIONARIES OF SCIENCE AND THEIR DUTY.

SIR,—It is perhaps somewhat bold for one of the rank and file in the great army of scientific workers to presume to criticise the action of his leaders. But when on all sides is heard the voice of widespread dissatisfaction with the proceedings of the British Association, perhaps the incipient mutiny may be pardoned.

The *Speaker* solemnly warns the association to put its house in order, or be prepared to go the way of the now defunct Social Science Association. Local papers in the town recently honoured by the presence of the association loudly complain that though a heavy tax is levied upon the town and district by the association, absolutely nothing is given by that body in return. Only one lecture of a popular character, that by Prof. Silvanus Thompson, was vouchsafed to the hungry souls that were thirsting for knowledge in the town, and that mainly owing to the determination of the professor himself. Perhaps it may be of advantage to enquire what the proper function of the British Association really is. If it were an exclusive body, such as the Royal Society, or the Institution of Civil Engineers, who paid a visit to certain localities at its own expense, aided possibly by subscriptions from its own local members and other sympathisers, no one would have any right to complain of the way in which it transacted its business. But it does not do this. It settles down upon the town it delights to honour for the year, like an octopus, embracing and practically stopping to a large extent the commercial life of the town. Numerous halls must be provided, and all the accessories of the headquarter staff of an army in the field, with its post and telegraph office, its executive, and, in addition, comfortable lounging-rooms. A large sum must be contributed by the people of the district, with the peculiar proviso that no matter how much an individual may subscribe to this local fund, he is not entitled to listen to any of the words of wisdom that are poured forth, unless he becomes for the time a member or associate. And all this is claimed on the ground that the presence of the association awakens the intellectual life of the town and district. Those who knew not what wonders science has wrought, and will do, are to know it now. The association is no exclusive body demanding guarantees of work done as a qualification for membership. Anyone may become a member or an associate, even a baby in its cradle, if only someone will pay the sum of one or two pounds into the coffers of the association.

And there is no doubt that large numbers of ladies and gentlemen join the association when it happens to be located in their midst, in the hope that they will learn something of the wonders of science they have heard about. But when the great parliament of science, as it has been inaptly termed, arrives, they find that in order to reap the harvest they had hoped for, they must belong to an inner trained circle. They may attend lectures upon supposed popular subjects—upon subjects they would be glad to hear about, but the lecturers might as well talk in Hindustani for the amount of information that is conveyed to the minds of at least 90 per cent. of their hearers. With every respect for the simple student who so ably filled the chair upon the present occasion, and for the splendour of his lifelong work, how many of his audience could possibly follow his opening address? How many, for instance, outside of the circle of scientific students know what a spectroscope is, and how many of those were able to grasp the method described by the president of measuring the approach or recess of certain fixed stars from our earth? How many, even among his audience, would understand what he meant by a measurement comprising so many seconds of arc?

So, too, with Prof. Rücker's lecture on "Electric Stress." To students of electrical phenomena it was a rare treat, and the writer of this article gratefully acknowledges many important truths learned from it. But to the mass of the audience, what interest could it have, beyond the appearance of light or its disappearance, and the appearance of certain colours or their non-appearance, just as the lecturer willed? And, except in rare cases, what lessons could they carry away.

It has been the same in other towns. At Bath, for instance, one of the lectures was given by an able professor of geology on "The Foundation Stones of the Earth's Crust"; but instead of the lecturer explaining to his audience how geologists make out that the earth has been built up in geological time, he proceeded to hold an intensely technical argument with some invisible opponent upon some theory of the formation of some particular rocks, and the argument, which was plentifully interspersed with such terms as gneisses and schists, was perfectly unintelligible and absolutely without interest to any but the geologists present. Is this fulfilling the duty which the British Association owes to those who support it, and to those for whom presumably it works? Does the advancement of science mean throwing the ball of argument round a particular circle of players, and never allowing outsiders a chance to join in the game? Does it mean keeping the achievements of science also within this charmed circle? Would it not be doing more real good, advancing the interests of science more substantially if outsiders—those who pay the bill—were allowed to listen to the tune. Surely it must be apparent that the object of discovery is not to be boxed up so that only a few can know of its existence, but to be spread broadcast, to bear fruit. Every scientific fact that a man or woman learns, and can apply intelligently, adds to the wealth of the world in some form or other; and the true missionary of science is he who proclaims his message in language that can be understood by everyone.

But there is also another and a very serious complaint urged against the association, and with good reason. Practical men say that its discussions and its papers are merely playing at science. They rarely advance science at all, because the papers are usually only half read, and *never* properly discussed. From seven to twenty papers are down to be read and discussed in the time required for one, consequently the first is *sometimes* read, never properly discussed, the second half read, and the rest lost. Why cannot these matters be arranged in a proper manner? Why should authors be asked to go to the trouble of preparing papers and diagrams, bringing up elaborate apparatus, and then to be met by the insulting request to read their papers to an audience of, say, three, or, if they do read them before a fairly large audience, to be constantly interrupted by reminders from the chairman that time is short?

How, also, is it possible to intelligently discuss a paper which you hear for the first time, and then perhaps in a garbled form, owing to the constant interruptions? Why cannot the example of the leading engineering institutes be followed—only as many papers be accepted as can be read and properly discussed, these papers carefully examined before being accepted and printed in advance, so that all who are interested in the subject can have an opportunity of studying the paper? Surely one paper given under these conditions would be worth a hundred given under the present arrangements.

Also, is it not possible to avoid the tactics of the election platform in discussions which take place on papers presented to the British Association? A smart personal sally may cause a laugh, but it is hardly conducive to the advancement of science, and is very undignified. Surely it should be within the power of the presidents of the sections to see that their discussions do not degenerate into personal squabbles, as unfortunately is too often the case at present. Mr. A differs from something stated in Mr. B's paper, forthwith Mr. C states that Mr. A knows nothing of the subject. Surely it would not only be more dignified, but more effective, for Mr. C to point out where Mr. A is wrong.

Also, would it not be best that there should be no favouritism shown in the selection and order of taking of the papers? Certainly give eminence the first place, but not friendship.

Further, are not three hours daily as much as human head and human eyes can endure, at any rate in one subject? Why not let some sections meet from ten till one, and others from two till five? The mornings or afternoons that were not engaged could well be devoted to the inspection of local works, etc. It often happens that a member is interested in two or more sections. The different branches of science all overlap each other, and one can never tell when one is going to receive a hint that will be useful in one's own branch, from something which appears before another branch. Geology, for instance, bears an important relation to "earth." It would be very convenient to attend, say, Section G in the morning and some other section in the afternoon; or, if there happened to be nothing on of interest in the afternoon, to go over some works or other object of interest in the neighbourhood. Possibly other members may offer other suggestions. At any rate, the writer hopes that there may be less cause for dissatisfaction at the Edinburgh meeting on the points he has named than there has been hitherto, and that the British Association, conforming to the altered conditions in which it finds itself, may become once more a body of true missionaries, bringing home the teachings of science, not only to the cultured few, but to everybody within its reach.—Yours, etc.,

SYDNEY F. WALKER.

THE GLASGOW ELECTRICAL ENGINEER.

As in the days to come local authorities will not only have their ordinary engineers, but also a specialist as electrical engineer answering somewhat in position to that of gas engineer, or water engineer, it may be as well to watch the gentlemen who secure these positions. One of the first appointments is that at Glasgow.

At the last meeting of the Town Council of Glasgow a recommendation from the Gas and Electric Lighting Committee to appoint Mr. William Arnot, of London, as the electrical engineer to the Corporation was approved of. There were about 50 applications for the appointment, the candidates hailing from all parts of the kingdom. After the first examination of the applications a list of 18 of the most likely men was made out, then a short list of six was selected, and each of these candidates had a personal interview with the subcommittee on electric lighting, after which it was unanimously agreed to recommend the appointment of the gentleman named above. Mr. Arnot, who is an associated member of the Institution of Civil Engineers, and a full member of the Institution of Electrical Engineers, is 36 years of age, and has an excellent "record," his practical experience in connection with the electric lighting industry being alike varied and extensive, and his training in theory and practice in the university and workshop having been very thorough. He had sole charge of the erection and maintenance of the Brixton central lighting station, in which both arc and incandescent plants were put down, and in which both overhead and underground circuits were run. He ran the mains for Plymouth Pier—arc and incandescent lamps, and laid several large underground mains, including those for Buckingham Palace. For over four years Mr. Arnot was employed in the electrical department of the Silvertown Works, and during that time, in addition to the usual electrical installation work, he superintended the laying down of all the plant for the Cannon-street central lighting station. In this case the plant embraced Babcock and Wilcox boilers and direct-driven engines, and dynamos for 1,000 lights, together with switchboards and fuseboards, which were of his own design. While in that employment he was also engaged in the estimating for electrical plants; indeed, he has had a large amount of experience in estimating for all classes of work, and has put down a number of installations with gas engines and secondary batteries. His experience also includes the fitting up electrically of a number of her Majesty's warships. For some time Mr. Arnot had the management of the engineering department of Messrs. Latimer Clark, Muirhead, and Co.'s works at Millwall, where he constructed a large number of dynamos, arc lamps, and other machinery. Then, again, it may be mentioned that he had for a length of time charge of the high-tension electric lighting station at the Grosvenor Gallery, when the directors decided to adopt Mr. Ferranti's system and engaged his services. Several years ago Mr. Arnot did some excellent work in connection with the laying of electric lighting mains in the country for Callender's Bitumen, Telegraph, and Waterproof Company, Limited, from whose manager he holds a high-class testimonial. During the past 18 months he has been employed as the electrical inspector for the London County Council, and his work in that capacity at the meter-testing station is spoken of in a very generous manner by Prof. Silvanus Thompson, who is the consulting electrical engineer to the Highways Committee of the County Council. After an acquaintanceship extending over six years, Mr. Ferranti likewise bears most excellent testimony in favour of Mr. Arnot, whom we must, in closing this notice, heartily congratulate on receiving the first appointment of the kind in Scotland, and in a city where he may expect to have Sir William Thomson as "guide, philosopher, and friend."

THE BRITISH ASSOCIATION AT CARDIFF.

PRESIDENTIAL ADDRESS BY WILLIAM HUGGINS, Esq.

(*Concluded from page 232.*)

The spectroscopic method of determining celestial motions in the line of sight has recently become fruitful in a new but not altogether unforeseen direction, for it has, so to speak, given us a separating power far beyond that of any telescope the glassmaker and the optician could construct, and so enabled us to penetrate into mysteries hidden in stars apparently single, and altogether unsuspected of being binary systems. The spectroscope has not simply added to the list of the known binary stars, but has given to us for the first time a knowledge of a new class of stellar systems, in which the components are in some cases of nearly equal magnitude, and in close proximity, and are revolving with velocities greatly exceeding the planetary velocities of our system.

The K line in the photographs of Mizar, taken at the Harvard College Observatory, was found to be double at intervals of 52 days. The spectrum was therefore not due to a single source of light, but to the combined effect of two stars moving periodically in opposite directions in the line of sight. It is obvious that if two stars revolve round their common centre of gravity in a plane not perpendicular to the line of sight, all the lines in a spectrum common to the two stars will appear alternately single or double.

In the case of Mizar and the other stars to be mentioned, the spectroscopic observations are not as yet extended enough to furnish more than an approximate determination of the elements of their orbits.

Mizar especially, on account of its relatively long period—about 105 days—needs further observations. The two stars are moving each with a velocity of about 50 miles a second, probably in elliptical orbits, and are about 143 millions of miles apart. The stars of about equal brightness have together a mass of about 40 times as great as that of our sun.

A similar doubling of the lines showed itself in the Harvard photographs of β Aurigæ at the remarkably close interval of almost exactly two days, indicating a period of revolution of about four days. According to Vogel's later observations, each star has a velocity of nearly 70 miles a second, the distance between the stars being little more than 7½ millions of miles, and the mass of the system 4·7 times that of the sun. The system is approaching us at the speed of about 16 miles a second.

The telescope could never have revealed to us double stars of this order. In the case of β Aurigæ, combining Vogel's distance with Pritchard's recent determination of the star's parallax, the greatest angular separation of the stars as seen from the earth would be 1-200th part of a second of arc, and therefore very far too small for the highest powers of the largest telescopes. If we take the relation of aperture to separating power usually accepted, an object glass of about 80ft. in diameter would be needed to resolve this binary star. The spectroscope, which takes no note of distance, magnifies, so to speak, this minute angular separation 4,000 times; in other words, the doubling of the lines, which is the phenomenon that we have to observe, amounts to the easily measurable quantity of 20 seconds of arc.

There were known, indeed, variable stars of short period, which it had been suggested might be explained on the hypothesis of a dark body revolving about a bright sun in a few days, but this theory was met by the objection that no such systems of closely revolving suns were known to exist.

The Harvard photographs, of which we have been speaking, were taken with a slitless form of spectroscope, the prisms being placed, as originally by Fraunhofer, before the object-glass of the telescope. This method, though it possesses some advantages, has the serious drawback of not permitting a direct comparison of the star's spectrum with terrestrial spectra. It is obviously unsuited to a variable star like Algol, where one star only is bright, for in such a case there would be no doubling of the lines, but only a small shift to and fro of the lines of the bright star as it moved in its orbit alternately towards and from our system, which would need for its detection the fiducial positions of terrestrial lines compared directly with them.

For such observations the Potsdam spectrograph was well adapted. Prof. Vogel found that the bright star of Algol did pulsate backwards and forwards in the visual direction in a period corresponding to the known variation of its light. The explanation which had been suggested for the star's variability—that it was partially eclipsed at regular intervals of 68·8 hours by a dark companion large enough to cut off nearly five-sixths of its light—was therefore the true one. The dark companion, no longer able to hide itself by its obscureness, was brought out into the light of direct observation by means of its gravitational effects.

Seventeen hours before minimum Algol is receding at the rate of about 24½ miles a second, while 17 hours after minimum it is found to be approaching with a speed of about 28½ miles. From these data, together with those of the variation of its light, Vogel found, on the assumption that both stars have the same density, that the companion, nearly as large as the sun, but with about one-fourth his mass, revolves with a velocity of about 55 miles a second. The bright star of about twice the size and mass moves about the common centre of gravity with the speed of about 26 miles a second. The system of the two stars, which are about 3¼ millions of miles apart, considered as a whole, is approaching us with a velocity of 2·4 miles a second. The great difference in luminosity of the stars—not less than 50 times—suggests rather that they are in different stages of condensation, and dissimilar in density.

It is obvious that if the orbit of a star with an obscure companion is inclined to the line of sight, the companion will pass above or below the bright star and produce no variation of its light. Such systems may be numerous in the heavens. In Vogel's photographs, Spica, which is not variable, by a small shifting of its lines reveals a backward and forward periodical pulsation due to orbital motion. As the pair whirl round their common centre of gravity, the bright star is sometimes advancing, at others receding. They revolve in about four days, each star moving with a velocity of about 56 miles a second in an orbit probably nearly circular, and possess a combined mass of rather more than 2½ times that of the sun. Taking the most probable value for the star's parallax, the greatest angular separation of the stars would be far too small to be detected with the most powerful telescopes.

If in a close double star the fainter companion is of the white-star type, while the bright star is solar in character, the composite spectrum would be solar with the hydrogen lines unusually strong. Such a spectrum would in itself afford some probability of a double origin, and suggest the existence of a companion star.

In the case of a true binary star the orbital motions of the pair would reveal themselves in a small periodical swaying of the hydrogen lines relatively to the solar ones.

Prof. Pickering considers that his photographs show 10 stars with composite spectra; of these, five are known to be double. The others are: τ Persei, ζ Aurigæ, δ Sagittarii, 31 Ceti, and β Capricorni. Perhaps β Lyræ should be added to this list.

In his recent classical work on the rotation of the sun, Dunér not only determined the solar rotation for the equator, but for different parallels of latitude up to 75deg. The close accordance of his results shows that these observations are sufficiently accurate to be discussed with the variation of the solar rotation for different latitudes, which had been determined by the older astronomical methods from the observations of the solar spots.

Though I have already spoken incidentally of the invaluable aid which is furnished by photography in some of the applications of the spectroscope to the heavenly bodies, the new power which modern photography has put into the hands of the astronomer is so great, and has led already, within the last few years, to new acquisitions of knowledge of such vast importance, that it is fitting that a few sentences should be specially devoted to this subject.

Photography is no new discovery, being about half a century old. It may excite surprise, and, indeed, possibly suggest some apathy on the part of astronomers, that though the suggestion of the application of photography to the heavenly bodies dates from the memorable occasion when, in 1839, Arago, announcing to the Académie des Sciences the great discovery of Niepce and Daguerre, spoke of the possibility of taking pictures of the sun and moon by the new process, yet that it is only within a few years that notable advances in astronomical methods and discovery have been made by its aid.

The explanation is to be found in the comparative unsuitability of the earlier photographic methods for use in the observatory. In justice to the early workers in astronomical photography, among whom Bond, De la Rue, J. W. Draper, Rutherfurd, Gould, hold a foremost place, it is needful to state clearly that the recent great successes in astronomical photography are not due to greater skill nor, to any great extent, to superior instruments, but to the very great advantages which the modern gelatine dry plate possesses for use in the observatory over the methods of Daguerre, and even over the wet collodion film on glass which, though a great advance on the silver plate, went but a little way towards putting into the hands of the astronomer a photographic surface adapted fully to his wants.

The modern silver-bromide gelatine plate, except for its grained texture, meets the needs of the astronomer at all points. It possesses extreme sensitiveness; it is always ready for use; it can be placed in any position; it can be exposed for hours; lastly, it does not need immediate development, and for this reason can be exposed again to the same object on succeeding nights, so as to make up by several instalments, as the weather may permit, the total time of exposure which is deemed necessary.

Without the assistance of photography, however greatly the resources of genius might overcome the optical and mechanical difficulties of constructing large telescopes, the astronomer would have to depend in the last resource upon his eye. Now, we cannot by the force of continued looking bring into view an object too feebly luminous to be seen at the first and keenest moment of vision. But the feeblest light which falls upon the plate is not lost, but is taken in and stored up continuously. Each hour the plate gathers up 3,600 times the light energy which it received during the first second. It is by this power of accumulation that the photographic plate may be said to increase, almost without limit, though not in separating power, the optical means at the disposal of the astronomer for the discovery or the observation of faint objects.

Two principal directions may be pointed out in which photography is of great service to the astronomer. It enables him within the comparatively short time of a single exposure to secure permanently with great exactness the relative positions of hundreds or even of thousands, of stars, or the minute features of nebulæ or other objects, or the phenomena of a passing eclipse, a task which by means of the eye and hand could only be accomplished, if done at all, after a very great expenditure of time and labour. Photography puts it in the power of the astronomer to accomplish in the short span of his own life, and so enter into their fruition, great works which otherwise must have been passed on by him as an heritage of labour to succeeding generations.

The second great service which photography renders is not simply an aid to the powers the astronomer already possesses. On the contrary, the plate, by recording light-waves which are both too small and too large to excite vision in the eye, brings him into a new region of knowledge, such as the infra-red and the ultra-violet parts of the spectrum, which must have remained for ever unknown but for artificial help.

The present year will be memorable in astronomical history for the practical beginning of the Photographic Chart and Catalogue of the Heavens, which took their origin in an international conference which met in Paris in 1887, by the invitation of M. l'Amiral Mouchez, director of the Paris Observatory.

The richness in stars down to the ninth magnitude of the photographs of the comet of 1882 taken at the Cape Observatory under the superintendence of Dr. Gill, and the remarkable star charts of the brothers Henry, which followed two years later, astonished the astronomical world. The great excellence of these photographs, which was due mainly to the superiority of the gelatine plate, suggested to these astronomers a complete map of the sky, and a little later gave birth in the minds of the Paris astronomers to the grand enterprise of an International Chart of the Heavens. The actual beginning of the work this year is in no small degree due to the great energy and tact with which the director of the Paris Observatory has conducted the initial steps through the many delicate and difficult questions which have unavoidably presented themselves in an undertaking which depends upon the harmonious working in common of many nationalities, and of no fewer than 18 observatories in all parts of the world. The three years since 1887 have not been too long for the detailed organisation of this work, which has called for several elaborate preliminary investigations on special points in which our knowledge was insufficient, and which have been ably carried out by Profs. Vogel and Bakhuyzen, Dr. Trépied, Dr. Scheiner, Dr. Gill, the Astronomer Royal, and others. Time also was required for the construction of the new and special instruments.

The decision of the conference in their final form provide for the construction of a great photographic chart of the heavens with exposures corresponding to 40 minutes' exposure at Paris, which it is expected will reach down to stars of about the fourteenth magnitude. As each plate is to be limited to four square degrees, and as each star, to avoid possible errors, is to appear on two plates, over 22,000 photographs will be required. For the more accurate determination of the positions of the stars, a *réseau* with lines at distances of 5 mm. apart is to be previously impressed by a faint light upon the plate, so that the image of the *réseau* will appear together with the images of the stars when the plate is developed. This great work will be divided, according to their latitudes, among 18 observatories provided with similar instruments, though not necessarily constructed by the same maker. Those in the British dominions and at Tacubaya have been constructed by Sir Howard Grubb.

Besides the plates to form the great chart, a second set of plates for a catalogue is to be taken, with a shorter exposure, which will give stars to the eleventh magnitude only. These plates, by a recent decision of the permanent committee, are to be pushed on as actively as possible, though as far as may be practicable plates for the chart are to be taken concurrently. Photographing the plates for the catalogue is but the first step in this work, and only supplies the data for the elaborate measurements which have to be made, which are, however, less laborious than would be required for a similar catalogue without the aid of photography.

Already Dr. Gill has nearly brought to conclusion, with the assistance of Prof. Kapteyn, a preliminary photographic survey of the southern heavens.

With an exposure sufficiently long for the faintest stars to impress themselves upon the plate, the accumulating action still goes on for the brighter stars, producing a great enlargement of their images from optical and photographic causes. The question has occupied the attention of many astronomers whether it is possible to find a law connecting the diameters of these more or less over-exposed images with the relative brightness of the stars themselves. The answer will come out undoubtedly in the affirmative, though at present the empirical formulæ which have been suggested for this purpose differ from each other. Captain Abney proposes to measure the total photographic action, including density as well as size, by the obstruction which the stellar image offers to light.

A further question follows as to the relation which the photographic magnitudes of stars bear to those determined by eye. Visual magnitudes are the physiological expression of the eye's integration of that part of the star's light which extends from the red to the blue. Photographic magnitudes represent the plate's integration of another part of the star's light, namely, from a little below where the power of the eye leaves off in the blue, to where the light is cut off by the glass, or is greatly reduced by want of proper corrections when a refracting telescope is used. It is obvious that the two records are taken by different methods in dissimilar units of different parts of the star's light. In the case of certain coloured stars the photographic brightness is very different from the visual brightness; but in all stars changes, especially of a temporary character, may occur in the photographic or the visual region, unaccompanied by a similar change in the other part of the spectrum. For these reasons it would seem desirable that the two sets of magnitudes should be tabulated independently, and be regarded as supplementary of each other.

The determination of the distances of the fixed stars from the small apparent shift of their positions when viewed from widely-separated positions of the earth in its orbit is one of the most refined operations of the observatory. The great precision with which this minute angular quantity, a fraction of a second only, has to be measured, is so delicate an operation with the ordinary micrometer—though, indeed, it was with this instrument that the classical observations of Sir Robert Ball were made—that a special instrument, in which the measures are made by moving the two halves of a divided object-glass, known as a heliometer, has been pressed into this service, and quite recently, in the skilful hands of Dr. Gill and Dr. Elkin, has largely increased our knowledge in this direction.

It is obvious that photography might be here of great service, if we could rely upon measurements of photographs of the same stars taken at suitable intervals of time. Prof. Pritchard, to whom is due the honour of having opened this path, aided by his assistants, has proved by elaborate investigations that measures for parallax may be safely made upon photographic plates, with, of course, the advantages of leisure and repetition; and he has already by this method determined the parallax for 21 stars with an accuracy not inferior to that of values previously obtained by purely astronomical methods.

The remarkable success of astronomical photography, which depend upon the plate's power of accumulation of a very feeble light acting continuously through an exposure of several hours, are worthy to be regarded as a new revelation. The first chapter opened when, in 1880, Dr. Henry Draper obtained a picture of the nebula of Orion; but a more important advance was made in 1883, when Dr. Common, by his photographs, brought to our knowledge details and extensions of this nebula hitherto unknown. A further disclosure took place in 1885, when the brothers Henry showed for the first time in great detail the spiral nebulosity issuing from the bright star Maia of the Pleiades, and shortly afterwards nebulous streams about the other stars of this group. In 1886 Mr. Roberts, by means of a photograph, to which three hours' exposure had been given, showed the whole background of this group to be nebulous. In the following year Mr. Roberts more than doubled for us the great extension of the nebula region which surrounds the trapezium in the constellation of Orion. By his photographs of the great nebula in Andromeda, he has shown the true significance of the dark canals which have been seen by the eye. They are in reality spaces between successive rings of bright matter, which appeared nearly straight owing to the inclination in which they lie relatively to us. These bright rings surround an undefined central luminous mass. I have already spoken of this photograph.

Some recent photographs by Mr. Russell show that the great rift in the Milky Way in Argus, which to the eye is void of stars, is in reality uniformly covered with them. Also quite recently Mr. George Hale has photographed the prominences by means of a grating, making use of the lines H and K.

The heavens are richly but very irregularly inwrought with stars. The brighter stars cluster into well-known groups upon a background formed of an enlacement of streams and convoluted windings and intertwined spirals of fainter stars, which becomes richer and more intricate in the irregularly rifted zone of the Milky Way.

We, who form part of the emblazonry, can only see the design distorted and confused; here crowded, there scattered, at another place superposed. The groupings due to our position are mixed up with those which are real.

Can we suppose that each luminous point has no relation to the others near it than the accidental neighbourship of grains of sand upon the shore, or of particles of the wind-blown dust of the desert? Surely every star from Sirius and Vega down to each grain of the light dust of the Milky Way has its present place in the heavenly pattern from the slow evolving of its past. We see a system of systems, for the broad features of clusters and streams and spiral windings which mark the general design are reproduced in every part. The whole is in motion, each point shifting its position by miles every second, though from the august magnitude of their distances from us and from each other, it is only by the accumulated movements of years or of generations that some small changes of relative position reveal themselves.

The deciphering of this wonderfully intricate constitution of the heavens will be undoubtedly one of the chief astronomical works of the coming century. The primary task of the sun's motion in space, together with the motions of the brighter stars, has been already put well within our reach by the spectroscopic method of the measurement of star-motions in the line of sight.

From other directions information is accumulating: from photographs of clusters and parts of the Milky Way, by Roberts, in this country; Barnard, at the Lick Observatory, and Russell, at Sydney, from the counting of stars, and the detection of their configurations, by Holden and by Backhouse; from the mapping of the Milky Way by eye, at Parsonstown; from photographs of the spectra of stars, by Pickering, at Harvard, and in Peru; and from the exact portraiture of the heavens in the great international star chart which begins this year.

I have but touched some only of the problems of the newer side of astronomy. There are many others which would claim our attention if time permitted. The researches of the Earl of Rosse on lunar radiation, and the work on the same subject and on the sun, by Langley. Observations of lunar heat with an instrument of his own invention, by Mr. Boys; and observations of the variation of the moon's heat with its phase, by Mr. Frank Very. The discovery of the ultra-violet part of the hydrogen spectrum, not in the laboratory, but from the stars. The confirmation of this spectrum by terrestrial hydrogen in part, by H. W. Vogel, and in its all but complete form by Cornu, who found similar series in the ultra-violet spectra of aluminium and thallium. The discovery of a simple formula for the hydrogen series by Balmer. The important question as to the numerical spectral relationship of different substances, especially in connection with their chemical properties; and the further question as to the origin of the harmonic and other relations between the lines and the groupings of lines of spectra; on these points contributions during the past year have been made by Rudolf v. Kovesligethy, Ames, Hartley, Deslandres, Rydberg, Grunwald, Kayser and Runge, Johnstone Stoney, and others. The remarkable employment of interference phenomena by Prof. Michelson for the determination of the size, and distribution of light within them, of the images of objects which when viewed in a telescope subtend an angle less than that subtended by the light-wave at a distance equal to the diameter of the objective. A method applicable not alone to celestial objects, but also to spectral lines, and other questions of molecular physics.

Along the older lines there has not been less activity; by newer methods, by the aid of larger or more accurately constructed instruments, by greater refinement of analysis, knowledge has been increased, especially in precision and minute exactness.

Astronomy, the oldest of the sciences, has more than renewed her youth. At no time in the past has she been so bright with unbounded aspirations and hopes. Never were her temples so numerous, nor the crowd of her votaries so great. The British Astronomical Association formed within the year numbers already about 600 members. Happy is the lot of those who are still on the eastern side of life's meridian!

Already, alas! the original founders of the newer methods are falling out—Kirchhoff, Angström, D'Arrest, Secchi, Draper, Becquerel; but their places are more than filled. The pace of the race is gaining, but the goal is not, and never will be in sight.

Since the time of Newton our knowledge of the phenomena of nature has wonderfully increased, but man asks, perhaps more earnestly now than in his days, what is the ultimate reality behind the reality of the perceptions? Are they only the pebbles of the beach with which we have been playing? Does not the ocean of ultimate reality and truth lie beyond?

RECENT PROGRESS IN THE USE OF ELECTRIC MOTORS.*

BY PROF. G. FORBES, F.R.S.

In any comparatively new industry, as electrical engineering, a great deal of mental "striction" must be got over to get people to adopt new methods even when known to be an improvement.

Lord Rayleigh in his presidential address in 1884 expressed his astonishment that while no addition to our electrical knowledge of 50 years previously was required to develop the dynamo, it was so slow in being introduced. The same is true in England now, even of electrical inventions which have been proved by long and extensive experience in other countries to be economically desirable.

It is the duty of engineers who see and inspect such work abroad, to urge upon people at home the importance of their inventions, and point out the troubles which have been met and overcome elsewhere so as to avoid failure, and to point out the directions in which different inventions are being adopted, modified, or rejected, as the result of extensive practical experience. Even in electric lighting, I am sure more than one company will admit that in following this rule some of us have saved them from buying costly experience in the past. In saying this I recognise the fact that all countries look upon England as having improved the dynamo more than any other country. In the application of electric motors I have noticed three directions in which this country needs the testimony of independent and impartial people to assist the value of applications which in some other countries are generally adopted. These are (1) electric railways, (2) replacing shafting in shops, especially for cranes, by electric conductors and motors, (3) transmitting power to a distance from waterfalls by means of electricity.

My remarks on these heads are largely founded on experience gained in visits to the United States, and also from a very thorough investigation of the utilisation of water power in all parts of Switzerland, undertaken this summer in conjunction with Prof. Unwin.

1. *Electric Railways.* — These are thoroughly established in America on the cheapest system—*i.e.*, electricity supplied from a central station by overhead wires. The extensive adoption of electric tram lines in America, and the small number in England, is entirely due to the fact that they allow these overhead conductors and we do not generally do so. The electric lines in America are one-half of the horse car lines in number, and are rapidly ousting horse lines as well as steam and cable lines; and yet it is extremely difficult to get correct figures of the cost. The most trustworthy estimates seem to vary between 4.18 and 6.00 cents per car mile, including coal, attendance, land, buildings, machinery, line, oil, water, and waste. The question of repairs is serious and must be reduced. Most of the lines adopt spur gearing to reduce the speed from the electric motor to the car axles. They generally use two pinions and two spur wheels. This introduces great friction. It is very generally accepted that 8 h.p. is lost in gear friction, though this seems somewhat incredible, being about 30 per cent. These cars are large, and the motors are 30 h.p. This enormous power is absolutely demanded to enable them to start on a gradient with facility, and they do this. There is no crawling about these cars. You feel that there is plenty of power for the work. The noise on these cars used to be very considerable, and the injury to watches through magnetisation was at one time an objection. The noise from the gearing, especially when worn, has been deadened by enclosing the motor and gearing in cast-iron boxes. The magnetisation of watches is prevented by adopting a suitable type of motor. The type first advocated, I believe, by Eickmeyer in America, and myself in England, in which the magnetising coils are wound round the armature when we want the magnetism instead of round the field magnets, is now being adopted by the Thomson-Houston Company, which has done such splendid work in street railways.

Another source of trouble in motors used to be the brushes, for sparking is liable to be very violent with the variable load of a tram motor, and the commutators wear away rapidly. Since my carbon brushes have been introduced this difficulty has entirely disappeared, and the motors can be used with any variation of load, and can be reversed without wearing of the commutator and with very little sparking. Even in stationary motors they are now generally adopting these brushes, and also in dynamos.

The loss in double reducing gear and the wear and tear led to all the important companies turning to single reducing gear with rather heavier motors. It would at first appear impossible to go further, and adopt armatures on the wheel axles without sacrificing the great advantage of gearing which allows the motors to be independently supported without being subjected to the same shocks as the wheel axles. In spite of this, the Westinghouse Company has introduced a gearless motor, which has strength enough to stand the shocks. But other inventors had the idea of fixing the armature alone on the axle and supporting the field magnet wholly on springs—to support it partially on springs is of little value. Now, with ordinary motors the armature cannot have up and down motion relatively to the pole-pieces. But Mr. Short, of the Brush Company, introduced a motor with pole-pieces, the sides of which allows an up and down motion without fear of the armature windings striking the pole-pieces. If the difficulty of end thrust is overcome, this ought to be an important step. But in this direction the most important and promising plan seems to be that adopted by Eickmeyer and Field. They support the whole motor in guides on springs, and connect the motor axle and the wheel axle by cranks and a coupling bar, the cranks on the right and left sides being at right angles to each other. This serves to reduce gearing friction to a minimum, while completely obviating shocks.

It may be well to give the result of American experience as to the injuries from shocks to the motor. In the first place, every manufacturer there has had to buy his own experience on one head—viz., that all loose wires such as those which join field magnet coils, or those passing from armature to commutator, are fractured by vibration. This experience has been universal, and the South London Electric Railway has also bought the same experience. The remedy lies in making such loose connections of flexible stranded wire. The other serious result of vibration is that the insulation, especially of the armature, is broken off, and short circuits occur. In America spur gearing is almost universal, but in Switzerland the Oerlikon Company are introducing worm gearing, which has been so much approved by M. Reckenzaun. Storage batteries have not generally been successful in America, but some trials have worked very well. In the last few years I have seen several of them in the States which seemed to promise well, but nothing has come of them.

The Thomson-Houston Company are now experimenting with heavy locomotives to drag trailer cars. They have not yet decided to adopt them, and in the plans proposed for rapid transit in New York I see a tendency to go in for separate motors on all the axles of a train, which is the only plan that utilises all the characteristic advantages of electric motor propulsion for long and rapid trains. We thus abolish the excessive weight of a locomotive, we are able to use lighter and less expensive rail, wear and tear of permanent way is diminished, and grinding action in going round curves. If trains are supplied by sufficient power they are not limited by rail friction to going up slight inclines, nor to getting up speed slowly. On a line with many stops the time occupied in a complete journey is thus largely reduced.

2. *Replacing Shafting by Electricity.*—The benefit of replacing shafting by electric conductors and motors has been thoroughly appreciated in America. Everyone knows of the hundreds of motors for small work which are supplied with electricity by central stations in Boston and New York besides other places, and of the large number of electric lifts supplied by the Otis Company, with the electric motors designed by Eickmeyer. I will only place before English manufacturers two of the establishments where a statement of what has been done is enough to bring conviction to the mind of every shrewd and sensible employer of power. In the great works of William Sellars and Co., shafting has been abolished as far as possible. I saw seven motors at work, chiefly on cranes. I saw a 15-h.p. Sprague motor working a 30-ton travelling crane, which has been in continuous use for the last two years. They, of course, use carbon brushes, and the motor has never given any trouble. Ordinarily working at 200 volts and 60 amperes, the latter have been increased to 110 for a short time without injury. There are also electric connections all over the shop, by means of which motors can be used at any time. The second establishment is Baldwin's locomotive factory, where 16 to 20 locomotives are sent off every week, and where space is so valuable that there is no room for shunt lines, and where a 100-ton travelling crane picks up one out of these 20 and puts it down where wanted. This fine travelling crane and every other crane in this huge part of the works are driven by electric motors.

3. *Transmitting Power to a Distance.*—With regard to transmission of power to a distance from waterfalls, I have seen little to chronicle in America, and what there is seems rather antiquated, but in Switzerland important work has been done by continuous and alternating currents. The high-tension electrical work in connection with continuous currents that most impressed me was what has been done by Cuenod, Sautter, and Co., Geneva. Their six-pole machines, with Gramme commutators, up to 2,000 volts, designed by M. Thury, seem to work admirably and sparklessly, and I must here state my conviction, which I did not previously have, that the insulation of such a machine can be made perfect, as there done, by supporting the dynamo or motor on a number of alternate slabs of vulcanised rubber and porcelain, and by connecting the shafts by Raffard couplings. This consists of a disc in the end of each of the two shafts to be coupled, which are as nearly in line as possible. Each disc has half-a-dozen steel pins on a circle near its periphery. In one of the discs the circle of pins is, say, 1ft. diameter, and in the other 1ft. 6in., and the two circles of pins are in the same place and are connected in pairs by india rubber rings. This avoids the necessity of perfect alignment and ensures perfect insulation At Oyonnax, a small village with artisans who make combs and wooden pipes and other articles, the lathes are driven by electric motors from a low-pressure supply. To get this power, a waterfall six miles distant is used. Each turbine, of 120 h.p., drives a dynamo of 1,800 volts, which is sent by overhead conductors to Oyonnax, where it drives a 1,800-volt motor, which drives a low-tension dynamo which supplies three three-wire circuits—one for power, one for public light, and one for private light. They have supplied similar plant in many other places.

I will not take up time with describing different works of this kind, but I will now say something about the use of multiphase or rotary currents, about the prospective use of which so much has been published. I have seen the machines and transformers in course of construction at Oerlikon, and the insulators which have been used, and the mechanical design is excellent. This plant is now about to be tried at Frankfort over a distance of 112 miles. Tests will be made, and we shall soon know something definite about their working. I have not seen the Dobrowolski machines, but both these and the others have been described in the technical journals. The principle employed by Mr. Brown, of Oerlikon, is the fact, discovered by Wilde, that an alternating dynamo used as a generator will drive a second similar machine as a motor; but three separate circuits are put on the armatures, so that three separate currents travel along the line and reach the electric motor in succession, so that there is always one circuit at least on the armature of the motor, tending to drive it round. Now these three currents in the line will interfere seriously with each other—just as it was found at New Orleans, that two circuits in unusual proximity for 1½ miles, and fed by two separate alternators, interfered with each other so much that the lamps on both circuits flickered badly. I find that, in order to prevent this, it is necessary that along the whole line the three conductors shall be at the corners of an equilateral triangle. I can quite understand the difficulties of regulation of three currents referred to by Dobrowolski, but I think there are further points upon which information is much wanted. I want to know—for hitherto I have entirely failed to see—the advantages of this three-phase synchronising alternator over the simple alternators which do such excellent work. I have been told that Mr. Brown's machine has 96 per cent. of efficiency as a dynamo. Well, I reply that an ordinary alternator without iron, not having the hysteresis of Mr. Brown's machine, ought to have a higher efficiency. In the next place, I am told by Mr. Brown that while you cannot switch one of these three-phase synchronising motors with its load on to an electric circuit and expect it to get up to the synchronising speed, yet it will do so along with the electric generator of electricity if the latter be also started from rest. In this it certainly has the advantage over the synchronising alternator with iron, but none whatever over those without iron, which will act in precisely the same way unless the motor happens to be stopped on dead centres—*i.e.*, with the centres of coils (in a Mordey alternator, for example) halfway between poles of the field magnets.

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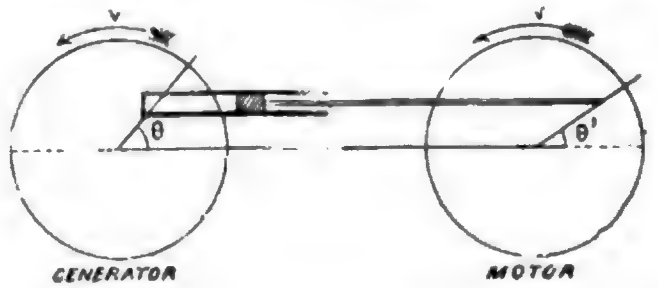
* Paper read before the British Association.

If this is the only gain over single-phase alternators with self-induction, and if there be no advantage gained over alternators without large self-induction, I fail to see the merit of the complication of three phases. I would not have drawn attention to the absence of advantage, but would have preferred to await the experiments before expressing an opinion, were it not for the great attention directed to the scheme by the Press, altogether out of proportion to the results which Mr. Brown and the Oerlikon managers hope to obtain. The great experiment about to be tried at Frankfort, which interests electricians all over the world, is not to prove that transformation is efficient, but to prove that 30,000 volts can be carred along 112 miles of overhead conductor. The Dobrowolski motor does not resemble the synchronising motor, but is a modification of the Tesla motor, except that the number of currents of differing phase is increased. Here also I fail to see any cause of better work, but I await any trials that may be made with interest, and I speak as one who has worked with and made tests with the developed type of Tesla motor at Pittsburg. Mr. Dobrolwolski, however, says that whatever load may be put on this motor there is no serious difference in phase between the potential difference applied to the motor (and there is no appreciable lag) and the current. If this be so, it would be a decided improvement, but I shall require strong proof before I accept the multiphase motor as a great advance over the Tesla machine. The only advantage which it possesses over synchronising alternators without iron in the armature, and with large momentum, lies in its power to start with load on. But I do not see that in large applications this advantage is to be compared with what it loses by its want of synchronism. All shops ought to be driven at a steady speed, but in some trades, such as weaving with sensitive looms, it is essential, and even the best turbines driven at nearly constant fall, if not governed, cause the breaking of threads in a loom to be a serious drawback. On the whole I would prefer the synchronising type. But Mr. Dobrowolski claims that these machines have the further advantage over the synchronisers that they will not stop when overloaded. Now this prevalent prejudice requires examination. For my own part, after having tested Mr. Mordey's synchronising alternators on many occasions, and after having very much overloaded them, I have a strong conviction, almost amounting to a feeling of certainty, that it is impossible to put them out of step in ordinary conditions by merely increasing the load. The more you increase the load, the more current goes through them to keep them in step. They would rather get red hot than get out of step. They behave just as a continuous-current motor, or a Tesla motor, or a Dobrowolski motor behave under the same conditions. It gets hots, but it does not stop. At this stage I must say that it is much to be deplored that no conclusive experiments by any independent authority have as yet been made on the Mordey alternator as to its efficiency when used as a motor.

In concluding my remarks about the Frankfort experiment, I wish to express the admiration that electricians feel for the men who have undertaken to prove that 30,000 volts can be practically transmitted overhead for 112 miles; and for the engineers who have so ably designed such excellent mechanical machines to do the work.

I now have a word to say on the alternating synchronising motor, which it seems so difficult to get people to believe in. I have for some time past been working at its theory. I will not go into the mathematics of it now. I will content myself with stating the conclusions, and replacing analytical or geometrical proofs by a mechanical analogy. People seem to be strangely at a loss to explain why it is that some alternators work well as motors while others do not. It has been shown that self-induction will assist this action. So many people have rushed to the conclusion that self-induction is the cause, and many a machine has been thrown away that was built on these lines. Mordey overthrew these views by showing that his machine, having less self-induction than most alternators, synchronised the best. Then, when we compare the Siemens or Ferranti alternator with the Mordey one, we see that they are electrically identical, especially as to self-induction. Why, then, does the Mordey work so well as a motor and not the Ferranti? The explanation is simply that the former has a large momentum and the other has not. I announced this explanation of the difficulty at a meeting of electricians in Paris last February, and found that M. Hospitalier had arrived at exactly the same conclusion and quite independently. I feel confident in predicting that the Ferranti dynamo, if supplied with a heavy enough flywheel, will be found to work as well as the Mordey machine as a motor. The reason of this is that the motor has dead centres to get over, just like a steam engine During the alternations the current is reduced to zero twice during each complete period, so also is the back E.M.F. of the motor, and at each of these points we have dead centres beyond which the motor cannot move except by flywheel action. During a considerable part of the complete period the motor has higher E.M.F. than the generator, and is consequently retarded. There is another point—viz., that the rotation of such a machine is not perfectly uniform. It is retarded when doing work, and accelerated when work is being done upon it, and the less the momentum the greater is the variation of speed. I will not go further into the theory, which I propose to give fully elsewhere, but the consideration of these views will be made clearer by a mechanical illustration.



Imagine two wheels on independent axles connected by a coupler which is not rigid, but consists of a piston attached to one of the wheels and a cylinder attached to the other; the piston working in the cylinder. If one of these is driven and slowly increased in speed, the other will rotate with it, but if it be loaded with a brake it cannot get over the dead centres unless it has momentum. Here the air friction, varying as the relative velocity of piston and cylinder, is the force which moves the motor wheel, and this corresponds to the electric current conveyed in the electric motor analogy. It is supposed that the wheels are so distant that the coupler is always parallel to the line of centre. The E.M.F. of either machine is represented by the inclination of the line of the coupler to tangent of the wheel at its point of attachment.

In the electrical problem, if θ and θ^1 are the phases of generator and motor, and if v and v^1 are their velocities at the moment, and if M and M^1 are the strengths of field, then, omitting self-induction altogether, their E.M.F.'s are proportional to

$$M\,v \sin\theta \text{ and } M^1 v^1 \sin\theta^1\,;$$

the current to

$$(M\,v \sin\theta - M^1 v^1 \sin\theta^1),$$

and the work on the motor to

$$M^1 v^1 \sin\theta^1 \,(M\,v \sin\theta - M^1 v^1 \sin\theta^1) \quad . \quad . \quad . \quad . \quad (A)$$

In the mechanical model the force transmitted is proportional to the relative motion of cylinder and piston—*i.e.*, to

$$v \sin\theta - v^1 \sin\theta^1,$$

and the pressure in the tangential direction moving the motor is

$$(v \sin\theta - v^1 \sin\theta^1) \sin\theta,$$

and the work on the motor is

$$v^1 \sin\theta^1 \,(v \sin\theta - v^1 \sin\theta^1),$$

which is an expression of exactly the same form as (A), the electrical expression. Hence, the mechanical effect in the electrical problem is exactly represented by the mechanical effect in this model, and the influence of momentum will be readily conceived by the mechanical engineer, and he will easily see that momentum is essential for synchronous acting when a load is on.

ELECTROLYTIC PROBLEMS.*

BY ROBERT L. MOND, B.A., F.R.S.E.

The study of Clerk Maxwell's theory of the propagation of electric energy through the dielectric along conductors, having through the magnificent experimental work of Hertz emerged from the purely mathematical stage, it may be of interest to apply it to the elucidation of the phenomena occurring on the propagation of electric energy through that class of conductors known as electrolytes.

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* Paper read before the British Association.

The propagation of electric energy along metallic conductors is invariably found to produce the following four phenomena:

I The electric energy is propagated with the velocity of light.

II. An electromagnet field is produced.

III. Induced currents are produced in neighbouring conductors.

IV. Heat is produced in the conductor uniformly along its length proportional to the strength of the current and the resistance of the conductor.

Those four phenomena are also produced during electrolysis. They are, however, accompanied by a fifth phenomenon—namely, chemical decomposition at the electrodes, and this chemical decomposition is strictly proportional to the strength of the current, but not to its intensity.

Hence, by infinitely increasing the potential and diminishing the strength of the current, we can make the absorption of electrical energy due to chemical action as small as we please; and thus we can establish so complete an analogy between the propagation of electric energy along metallic conductors and along electrolytes that any views brought forward to explain the phenomena in the one case must perforce apply to the other.

The theory of the propagation of electric energy along metals has been thus concisely defined by Prof. J. J. Thomson:

"The velocity of transmission of an electric impulse along a wire is, according to Maxwell's theory, equal to the velocity with which light passes through the dielectric in which the energy resides, and the function of the wire seems merely to be that of guiding the discharge which travels at a rate fixed by the dielectric."

Prof. H. Hertz has recently shown that when an electric oscillation travels along a wire the electric force produces a mechanical effect at right angles to the wire, whilst the magnetic force which accompanies it tends to repel a ring brought into its vicinity; thus there are two vibrations perpendicular to each other, the nodes of the one coinciding with the antinodes of the other, passing along the wires, whence he concludes that "from the above experiments with conductors of very simple form it is evident that a conductor of any form, when placed in the path of electromagnetic wires, is subject to forces of a very complex character."

Since a guiding conductor surrounded by dielectric is required (according to the above theory) for the propagation of electric energy in definite directions, the question arises, "How can an electrolyte act as such a guiding conductor?"

For this there are two possible explanations. Either (I.) the bulk of the electrolyte might be considered the conductor, and the surrounding medium the dielectric, such as glass or air, or (II.) in the electrolyte itself a rearrangement of molecules is produced, some (*i.e.*, the best conducting) forming the guiding conductors along the lines of force between the electrodes, other dielectric tubes surrounding the same.

The first proposition is untenable, for although it explains how an electromagnetic field may be produced outside the electrolyte, it utterly fails to explain how a fairly uniform field is produced inside it.

Molecular chains have formed the basis of every theory of electrolysis since they were first proposed by Grotthus, although the mode of action of the molecules has been explained in a great number of different ways.

The molecular arrangement required for the second proposition—*i.e.*, molecular chains surrounded by dielectric tubes—was first proposed by Prof. G. Wiedemann, who brings weighty proofs in its favour, but who also, like his predecessors, assumes that the current passes through the molecular chain. He has, however, provided the requisite mechanism for the application of Clerk Maxwell's theory to electrolysis.

The electric energy in being propagated through these dielectric tubes along the chain of conducting molecules produces these magnetic and electric effects, which act chemically on the dielectric, decomposing the molecules into atoms or weakening their affinity along the zones of intense electric action surrounding each molecular chain. A similar view was already suggested by Faraday, when he considers the electric current to be "an axis of power having contrary forces exactly equal in amount in opposite directions," modifying the chemical affinity of the electrolyte in directions parallel to the axis, and providing the conditions for the transfer of electro-positive and negative ions in their respective directions.

That there is a tendency for a strong electric field to produce molecular decomposition is evident from the action of the silent discharge and the [illegible], and also from such observations as those made by Bouty of electrolytic action on the surface of condenser plates.

The view proposed, which considers metallic and electrolytic conduction as identical, finds strong support in the following investigations.

Prof. J. J. Thomson finds, as the result of experiments, "that the velocity of propagation of a rapidly alternating current along an electrolyte surrounded by air cannot differ much from the rate along a wire"; and in examining the resistance of electrolytic alternating currents, "The results obtained agree sufficiently well to enable us to say that the relative resistance of electrolytes is the same when a current is alternating a hundred million times a second as for a steady current."

Prof. Mengarini, of Rome, in a very exhaustive paper on electrolysis by alternating currents, formulates the following law: "4. A limiting value to the rapidity of alternations exists, beyond which decomposition does not take place," which he proves both theoretically and experimentally; and he finds that at the limit "the voltameter only becomes heated by the passage of the current like an ordinary metallic conductor. He also states in his conclusions: "6. A voltameter traversed by an alternating current behaves like a metallic conductor possessing self-induction."

A committee appointed by the British Association has also investigated a series of solid compounds—such as sulphides and selenides—some of which conduct purely metallicly, others purely electrolytically, and others in both ways at the same time, and declared themselves unable to draw any marked line of distinction between these bodies.

To resume. The number of the molecular chains formed will depend on the strength of the electric field and on the concentration of the electrolyte, whilst the cross-sectional area of each zone of decomposition will depend on the strength of the current and number of chains, and the current density will be measured by the number of such chains in the cross-section of the electrolyte.

The existence of these zones explains—

I. How the atoms can travel along molecular chains towards their respective electrodes without recombination.

II. Why the atoms are given off as molecules at the electrodes only, because there the electric field, being weakest, and atoms of one kind preponderating, they combine and are given off.

By artificially weakening the electric field by introducing a metallic plate into the path of the molecular chains, such plate acts similar to an electrode. Mr. A. Tribe, by interposing silver plates in a copper sulphate cell, obtained one end coated with copper, the other with protoxide of silver, and found the boundary line of the zone of deposition to be at right angles to the line of flow of the current. This enabled him to observe the refraction of this line of flow by interposing a porous vessel with water, whose parallel sides were inclined at an angle of 45deg. to the sides of the rectangular electrolytic trough, a most important verification of the directive tendency of the current in an electrolyte.

Prof. J. J. Thomson has also shown that an electric field is weakened in the presence of a solid dielectric, because the surface tension is increased. Hence, if a solid dielectric is intruded into a zone of intense electric action, by sending the current through a porous diaphragm or a cracked glass plate, the fields will be weakened and atoms liberated, as abundantly proved by the experiments of Grotthus, F. Braun, Ostwald, Tamman, Overbeck, and others.

III. Why the atoms cannot escape through out of the liquid is explained by the directive force preventing the atoms escaping laterally out of the decomposing zones.

It is obvious that only an exceedingly small E.M.F. would be required to produce the minimum zone of decomposition necessary for electrolysis along a single or few molecular chains, and, since a weak electric field could only have a few lines of force, there would only be a few such rows, and this gives us an explanation for the electrolysis produced by the infinitesimal currents observed by Helmholtz, M. Deprez, and others.

Also, if two bad conductors of slightly varying conductivity be mixed—such as alcohol and water—the conditions are provided for electrolytic action, the better conducting forming the guiding conductors, the other dielectric tubes, whence a greatly increased conducting power is produced and observed; as witness the experiments of Gladstone and Tribe, Overbeck, Pouillet, Ayrton and Perry, and others.

This also explains the action of exceedingly minute quantities of impurities on influencing the conductivity of electrolytes.

The assumption that the solvent is primarily decomposed suffices to explain all the chemical phenomena observed in electrolytic cells, and was fully accepted by the older electricians, being specially worked out by Berzelius and his school.

The electrolysis of solutions by strong currents gives strong support to this view, for when constituents of the solvents are more rapidly generated than they can be absorbed by secondary chemical action they are given off in the free state. I have shown this to be the case for copper sulphate solutions, from which I have obtained oxygen and hydrogen by sufficiently increasing the strength of the current. Kohlrausch also states that in very dilute solutions water is decomposed.

The complicated phenomena classed under polarisation are mainly due to voltaic currents arising from chemical changes taking place at the electrodes and their physical effects.

The phenomenon known as wandering of the ions has been shown by Profs. Wiedemann and Quincke to be due to three causes.

I. The free charges on the surface of the molecular chains, producing motion in opposite directions of the salt and the solvent molecules.

II. The same effect being also produced by the free charges on the electrodes; and

III. By the electrification of the vessel containing the electrolyte, which latter they also consider to explain the phenomena known as electrical endosmose.

It is obvious that these explanations may also be adopted in connection with the above expressed views.

In order to corroborate the theory of molecular chains, I have carried out a series of experiments with different apparatus to study whether the displacement of the molecular conductors would influence the conductivity. I found that the resistance of a jet of electrolyte, which was caused to flow at varying speeds between the electrodes, rose proportional to the velocity of the electrolyte up to a maximum of about 10 per cent. of the total deflection. In order to ensure the result being solely due to the velocity of the jet and not to diminution of the area of the conductor, the electrodes, carefully insulated except at the places where the jets, one to each electrode, impinged, were kept immersed in separate cells connected with a tube and provided with overflow tubes, the jet playing beneath the surface of the electrolyte. The result was in complete accordance with those previously obtained.

Faraday has shown that an interrupted current flowing through an electromagnet is able to induce a current in a secondary coil made of an indiarubber tube filled with an electrolyte wound round the keeper.

Considering it to be of interest to have both a primary and secondary coil of electrolytic conductor, I constructed two flat spirals of indiarubber tubing filled with acidulated copper sulphate, and provided with copper electrodes; for the primary a continuous current of 90 volts was employed, which was simply interrupted by means of an electric bell worked from an independent battery.

The secondary coil was connected with a Sir Wm. Thomson 60-ohm reflecting galvanometer; a thermo current giving 10 divisions was observed, but the effect of the induced alternating current was to produce intermittently deflections of over 50 divisions on each side of the zero, thus removing all doubt of the success of the experiment.

The complete analogy between an electrolyte and a high-resistance wire led me to suspect that if such a wire were inserted between the electrodes, electrolysis would be observed at the ends. On referring to the literature I found that Jacobi had obtained the desired result with a German silver wire in a copper sulphate solution, but did not obtain the result with platinum. Having some thin platinoid wire at hand I determined to repeat the experiment, coiling the wire to increase its resistance. Copper was deposited along about one half of it, beginning slowly at the negative electrode whilst the other half turned black by oxidation, and was gradually destroyed at the end nearest the positive electrode.

I know that the view I have ventured to bring before you leaves many facts connected with electrolysis as yet unexplained, but the same must be admitted for all other theories on the subject hitherto propounded, over which it has, I believe, the advantage that it brings the propagation of electric energy along electrolytes into harmony with the now generally accepted theory of Clerk Maxwell of its propagation along metallic conductors, and that it offers an explanation of the electrical as well of the chemical phenomena observed.

ON THE ELECTROMAGNETIC THEORY OF THE ROTATION OF THE PLANE OF POLARISED LIGHT IN A MAGNETIC FIELD.*

BY PROF. A. GRAY, M.A.

Sir William Thomson has explained the turning of the plane of polarised light in a magnetic field by supposing the ether to have embedded in it a large number of small gyrostats, having the undisturbed positions of their axes in the common direction of the magnetic force, and the propagation of the beam, and all rotating in the same sense. When, in consequence of the vibratory motion, each gyrostat has its axis of rotation displaced from this direction it reacts on the surrounding medium with transverse force at right angles to the plane through the axis of rotation and the direction of motion.

By compounding this stress with the elastic forces of displacement of the ether, differential equations of motion are obtained which are of precisely the form necessary to account for the difference in rate of propagation of the two circularly polarised rays constituting the plane polarised ray.

The equations thus found are of the form:

$$\rho\frac{\delta^2 \xi}{\delta t^2} = n\frac{\delta^2 \xi}{\delta z^2} + c\rho\frac{\delta^3 \eta}{\delta t\,\delta z^2}$$

$$\rho\frac{\delta^2 \eta}{\delta t^2} = n\frac{\delta^2 \eta}{\delta z^2}c - \rho\frac{\delta^3 \xi}{\delta t\,\delta z^2}$$

where ξ η denote component displacements of a portion of ether in two rectangular directions, perpendicular to that of z, taken as the direction of propagation.

It is suggested by the gyrostatic investigation that it ought to be possible to explain the magneto-optic rotation on the electromagnetic theory of light, as a consequence of the existence of the similarly oriented small magnets which are supposed embedded in the medium with their axes in the direction of propagation of the ray, and therefore producing the magnetisation of the medium in that direction. Such a theory, while analogous to the gyrostatic theory, would be quite independent of the latter.

In consequence of the motions of the ether, the directions of the chains of magnetised molecules, which are supposed to exist along the direction of magnetisation (here taken as axis of z), in the undisturbed state of the medium, are continually undergoing change at every point, and thus the direction of the axial magnetic force along each chain also undergoes alteration. It is obvious that if the displacements be everywhere small the actual magnitude of this force will sustain only a very small percentage of alteration, but that each such small change of direction will produce a component magnetic force in each of the two directions at right angles to the axis. The calling into existence of these components will produce corresponding E.M.F.'s tending to increase or diminish the electric displacement.

The E.M.F. in the direction of y is given in Maxwell's notation by

$$Q = \frac{dG}{dt} - \frac{\delta\psi}{\delta y},$$

where dG/dt stands for the total time-rate of change of G, the component of vector potential in the direction of y, and δ denotes partial differentiation. Also since H, the component along z, does not perceptibly vary along x, if the direction of propagation be as taken here along z $-\delta G/\delta z$, denotes magnetic induction through unit of area in the plane of $y\,z$. Hence any part of the total time-rate of variation of $-\delta G/\delta z$ will denote the space-rate of variation, in the direction of z, of an E.M.F. parallel to y, provided the time and space differentiations of the part are commutative. This is to be borne in mind in what follows.

Now, if the displacement of the ether particles from the undisturbed positions be taken as parallel and proportional to the electric displacement, and C be the component of magnetisation of the substance in the direction of z due to the existence of the molecular magnets, then, considering the electric displacement f in the direction of x, the component magnetic force in the direction of x will be, approximately, $e\,C\,\delta f/\delta z$, and thus the magnetic induction through unit of area in the plane of $y\,z$ is $\mu\,e\,C\,\delta f/\delta z$, where e is a coefficient of proportionality. The time-rate of variation of this is

$$\mu\,e\,C\frac{\delta}{\delta t} \times \frac{\delta f}{\delta z}.$$

But we have by the equations of electric currents

$$\frac{\delta f}{\delta t} = \frac{1}{4\pi}\left(\frac{\delta\gamma}{\delta y} - \frac{\delta\beta}{\delta z}\right) = -\frac{1}{4\pi}\frac{\delta\beta}{\delta z}$$

since there is no conduction current.

Further, by the relation of magnetic force to vector potential, $\beta = (\delta F/\delta z)/\mu$, and therefore the last equation becomes

$$\frac{\delta f}{\delta t} = -\frac{1}{4\pi\mu}\frac{\delta^2 F}{\delta z^2}.$$

Now, since the differentiation of f with respect t is partial only, we may use the substitution

$$\frac{\delta}{\delta z}\frac{\delta f}{\delta t} = \frac{\delta}{\delta t}\frac{\delta f}{\delta z}.$$

Hence, differentiating $\delta f/\delta t$ with respect to z, we find

$$\mu\,e\,C\frac{\delta}{\delta t}\frac{\delta f}{\delta z} = \frac{e\,C}{4\pi}\frac{\delta^3 F}{\delta z^3},$$

which gives an E.M.F. in the direction of y of amount

$$\frac{-e\,C\,\delta^2 F}{4\pi\,\delta z^2},$$

since there can be no constant or arbitrary time function concerned. Hence we have, finally,

$$Q = -\frac{\delta G}{\delta t} - \frac{e\,C}{4\pi}\frac{\delta^2 F}{\delta z^2} - \frac{\delta\psi}{\delta y},$$

and therefore $$\frac{\delta Q}{\delta t} = -\frac{\delta^2 G}{\delta t^2} - \frac{e\,C}{4\pi}\frac{\delta^3 F}{\delta t\,\delta z^2}.$$

But the displacement current in the direction of y is dg/dt, and this is $K/4\pi\,.\,\delta Q/\delta t$. Also by the equations of currents $\delta g/\delta t = -1/4\pi\mu\,\delta^2 G/\delta z^2$. Therefore we have the equation

$$\frac{K}{4\pi}\frac{\delta Q}{\delta t} = \frac{\delta g}{\delta t} = -\frac{1}{4\pi\mu}\frac{\delta^2 G}{\delta z^2},$$

which, used in the equation already found for $\delta Q/t$, yields

$$\frac{\delta^2 G}{\delta t^2} = \frac{1}{K\mu}\frac{\delta^2 G}{\delta z^2} - \frac{e\,C}{4\pi}\frac{\delta^3 F}{\delta t\,\delta z^2}.$$

Similarly for the other component in the case of circularly polarised light we find the equation,

$$\frac{\delta^2 F}{\delta t^2} = \frac{1}{K\mu}\frac{\delta^2 F}{\delta z^2} + \frac{e\,C}{4\pi}\frac{\delta^3 G}{\delta t\,\delta z^2}.$$

These two equations are identical in form with those quoted above, as given by the gyrostatic theory, and, of course, lead to the same results; that is to say, the plane of polarisation of an electromagnetic beam would show a turning effect in a magnetised medium.

The theoretical view given above has been suggested by a reference in M. Poincaré's "Théorice de Maxwell," to a note by M. Potier, in his French translation of "Maxwell's Electricity," which appears to contain a similar theory leading to equations of the same form. I have not seen M. Potier's note, and it is possible that it has completely anticipated the present paper.

The fundamental assumption here made, that f, g, h are proportional to the ether displacements seems a reasonable one, and is in accordance with the view generally held (but not yet, so far as I know, proved) with respect to the electromagnetic propagation of light. If the theory given above be otherwise satisfactory, it seems to give, by accounting for the magneto-optic effect, some support to this view. It will be observed that theory, while independent of the gyrostatic one, is analogous to the latter, the transverse E.M.F.'s in the electromagnetic theory corresponding precisely to the gyrostatic reactions in the dynamical one.

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* Abstract of a paper read before the British Association.

REPORT OF THE COMMITTEE ON ELECTRICAL STANDARDS.*

Report of the committee consisting of Prof. G. Carey-Foster, Sir William Thomson, Prof. Ayrton, Prof. J. Perry, Prof. W. G. Adams, Lord Rayleigh, Dr. O. J. Lodge, Dr. John Hopkinson, Dr. A. Muirhead, Mr. W. H. Preece, Mr. Herbert Taylor, Prof. Everett, Prof. Schuster, Dr. J. A. Fleming, Prof. G. F. FitzGerald, Mr. R. T. Glazebrook (secretary), Prof. Chrystal, Mr. H. Tomlinson, Prof. W. Garnett, Prof. J. J. Thomson, Mr. W. N. Shaw, Mr. J. T. Bottomley, and Mr. T. Gray, appointed for the purpose of constructing and issuing practical standards for use in electrical measurements.

The work of testing resistance coils at the Cavendish Laboratory has been continued. A table of values found for the coils is appended.

B.A. UNITS.

No. of unit.	Resistance in B.A.U.	Temperature.
Elliott 245 —74	·99954	11·9
Elliott 246 —75	·99949	12·15
Elliott 248 —76	·99988	13·9
B.A. No. 38—77	1·00023	15·7
Elliott 257 —78	1·00046	15·6

LEGAL OHMS.

No. of coil.		Resistance in legal ohms.	Temperature.
McWhirter	L O —200	·99836	13·9
Elliott	244—202	·99871	11·75
Elliott	250—203	·99924	13·9
Nalder	3,081—204	·99868	15·2
Elliott	258—205	·99985	15·4
Elliott	259—206	·99075	15·5
Elliott	260—207	10·0019	15·6
Nalder	2,018—208	10·0066	17·8
Nalder	2,020—209	100·056	17·7

OHM COILS.

No. of coil.		Resistance in ohms.	Temperature.
Elliott	243—201	·99948	11·85
Elliott	267—325	1·00040	16·
Nalder	3,059—326	1·00005	16·8

Among these the coil B.A. No. 38—77 has a special interest. It is an original platinum-silver coil which formerly belonged to Prof. Balfour Stewart, and is now in the possession of Prof. Schuster, at the Owens College. According to the label on it, it was right at 16deg. 5. According to my observations, its value is one mean B.A. unit at 14·9. This coil, therefore, would appear to have risen in value since about 1867 by ·0006 B.A.U., and this result is not in accordance with the conclusions deduced in 1878 from the observations on the other platinum-silver coils then examined.

Some further experiments have been made with satisfactory results on the air condensers of the association. A megohm resistance-box has been purchased for use in comparisons of capacity. With a view to testing the permanence of the resistance standards, it was thought desirable to compare them again with the mercury standards. This was done in December and January by the secretary. The coil that was compared with two mercury tubes constructed in 1884 by M. J. R. Benoit, which had been filled at Cambridge early in the year 1885 and had remained full since. An account of the comparison was read before the Physical Society, May 9, 1891, and appears in the *Phil. Mag.* for July, 1891. The coils were compared with the B.A. standards, if we take, as was done in 1885, for the resistance in B.A. units of a column of mercury 100 cm. long, 1deg. in section, the value ·95412 B.A.U. We have the following results for the resistance of the tubes in legal ohms :

No.	Value in 1885 found by R T *b*.	Value in 1891 found by R T *b*.
37	99990	99986
39	99917	99913

The differences are only ·00004 legal ohm, which is too small to feel really certain of. If we accept for the resistance of mercury the value ·95352, which (B.A. Report, 1890) appears the best value, then we have

No.	Value given by Benoit, 1885.	Value found by R T *b* in 1891.
37	1·00045	1·00033
39	·99954	·99959

These comparisons were made with Ha^{1}, and lead to the conclusion that it has remained unchanged. In November, 1890, the association was invited by the President of the Board of Trade to nominate two members to represent the association on a committee "on standards for the measurement of electricity for use in trade." A meeting of the Electrical Standards Committee was held on December 2nd, and it was agreed to suggest to the council of the association the names of Prof. Carey-Foster and Mr. R. T. Glazebrook as representatives. These gentlemen were appointed by the Board of Trade, together with Mr. Courtenay Boyle, C.B., Major Cardew, Mr. E. Graves, Mr. W. H. Preece, Sir William Thomson, Lord Rayleigh, Dr. John Hopkinson, and Prof. Ayrton. This committee, after various meetings, drew up a report, a copy of which is printed as Appendix I. to this report. The standards of resistance, constructed in accordance with Resolution 6 of the report, are now in the hands of the secretary, and are being compared with the standards of the association. Numerous experiments on the methods of constructing Clark's cells and on the absolute E.M.F. of such cells have been made at the Cavendish Laboratory by Mr. Wilberforce, Mr. Skinner, and the secretary. These are still incomplete, but the experiments, so far as they have been finished, lead to the value 1·434 volts at 15deg. for the E.M.F. of the cell. The value found by Lord Rayleigh was 1·435 at the same temperature.

Mr. Fitzpatrick has continued his experiments on the resistance of silver. An account of these will be found in Appendix II. The committee ask for reappointment, with omission of the names of Principal Garnett and Mr. H. Tomlinson, and addition of those of Dr. G. Johnstone Stoney and Prof. S. P. Thompson. They recommend that Prof. Carey-Foster be chairman, and Mr. R. T. Glazebrook secretary. They further ask to be allowed to retain an unexpended balance of last year's grant, amounting to £17. 4s. 6d., as well as for a new grant of £10.

APPENDIX I.

Report of the Electrical Standards Committee appointed by the Board of Trade to the Right Hon. Sir Michael Hicks-Beach, Bart., M.P., President of the Board of Trade.

In compliance with the instructions contained in your minute of the 16th December last, that we should consider and report whether any, and if so what, action should be taken by the Board of Trade under Section 6 of the Weights and Measures Act, 1889, with a view to causing new denominations of standards for the measurement of electricity for use for trade to be made and duly verified, we have the honour to submit the following report. 1. Before coming to a decision as to the points referred to us, we were anxious to obtain evidence as to the wishes and views of those practically interested in the question, as well as of local authorities who are concerned in the administration of Weights and Measure Acts. 2. With this view we prepared draft resolutions embodying the proposals which, subject to further considerations, appeared to us desirable, and forwarded copies to the representatives of various interests for criticism. Copies were also forwarded to the Press. We also invited the following bodies to nominate witnesses to give evidence before us : the Association of Chambers of Commerce of the United Kingdom, the Association of Municipal Corporations, the London County Council, and the London Chamber of Commerce. 3. In response to this invitation the following gentlemen attended and gave evidence : on behalf of the Association of Chambers of Commerce, Mr. Thos. Parker and Mr. Hugh Erat Harrison ; on behalf of the London Council, Prof. Silvanus Thompson ; on behalf of the London Chamber of Commerce, Mr. R. E. Crompton. The Association of Municipal Corporations did not consider it necessary to offer any oral evidence, but the following resolution passed by the Law Committee of that body was adopted by the council of the association : "The committee are of opinion that, assuming that the science of electricity has advanced so far that it is now possible properly to define the three units referred to in the Board of Trade letter—*i.e.*, the ohm, ampere, and volt—and to construct an instrument for the purpose of standard measurement, the time has arrived for the Board of Trade to take action thereon." 4. In addition to the witnesses above referred to, the following gentlemen were invited to give evidence, and we are indebted to them for valuable information and assistance : Dr. J. A. Fleming, and Dr. Alexander Muirhead. 5. We also had the advantage of the experience and advice of Mr. H. J. Chaney, superintendent of weights and measures, who, at the request of our chairman, was present at our meetings. 6. After a careful consideration of the questions submitted to us, and the evidence given by the various witnesses, we have agreed to the following resolutions :

"1. That it is desirable that new denominations of standards for the measurement of electricity should be made and approved by her Majesty in Council as Board of Trade standards. 2. That the magnitudes of these standards should be determined on the electromagnetic system of measurement with reference to the centimetre as unit of length, the gramme as unit of mass, and the second as unit of time, and that by the terms centimetre and gramme are meant the standards of those denominations deposited with the Board of Trade. 3. That the standard of electrical resistance should be denominated the ohm, and should have the value 1,000,000,000 in terms of the centimetre and second. 4. That the resistance offered to an unvarying electric current by a column of mercury of a constant cross-sectional area of one square millimetre, and of a length of 106·3 centimetres at the temperature of melting ice, may be adopted as one ohm. 5. That the value of the standard of resistance constructed by a committee of the British Association for the Advancement of Science in the years 1863 and 1864, and known as the British Association unit, may be taken as ·9866 of the ohm. 6. That a material standard, constructed in solid metal, and verified by comparison with the British Association unit, should be adopted as the standard ohm. 7. That for the purpose of replacing the standard, if lost, destroyed, or damaged, and for ordinary use, a limited number of copies should be constructed, which should be periodically compared with the standard ohm and with the British Association unit. 8. That resistances constructed in solid metal should be adopted as Board of Trade standards for multiples and sub-multiples of the ohm. 9. That the standard of electrical current should be denominated the ampere, and should have the value one-tenth (0·1) in terms of the centimetre, gramme, and second. 10. That an unvarying current which when passed through a solution of nitrate of silver in water, in accordance with the specification attached to this report, deposits silver at the rate of 0·001118 of a gramme per second, may be taken as a current of one ampere. 11. That an alternating current of one ampere shall mean a current such that the square root of the time-average of the square of its strength at each instant in amperes is unity. 12. That instruments constructed on the principle of the balance, in which by the proper disposition of the conductors forces of attraction and repulsion are produced, which depend upon the amount of current passing, and are balanced by known weights, should be adopted as the Board of Trade standards for the measurement of current, whether unvarying or alternating. 13. That the standard of electrical pressure should be denominated the volt, being the pressure which, if steadily applied to a conductor whose resistance is one ohm, will produce a current of one ampere. 14. That the electrical pressure at a temperature of 62deg. F. between the poles or electrodes of the voltaic cell known as Clark's cell, may be taken as not differing from 1·433 volts by more than an amount which will be determined by a sub-committee appointed to investigate the question, who will prepare a specification for the construction and use of the cell. 15. That an alternating pressure of one volt shall mean a pressure such that the square root of the time-average of the square of its value at each instant in volts in unity. 16. That instruments constructed on the principle of Sir W. Thomson's quadrant electrometer used idiostatically, and for high-pressure instruments on the principle of the balance, electrostatic forces being balanced against a known weight, should be adopted as Board of Trade standards for the measurement of pressure, whether unvarying or alternating."

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* Report presented to the British Association.

7. We have adopted the system of electrical units originally defined by the British Association for the Advancement of Science, and we have found in its recent researches, as well as in the deliberations of the International Congress on Electrical Units, held in Paris, valuable guidance for determining the exact magnitude of the several units of electrical measurement, as well as for the verification of the material standards. 8. We have stated the relation between the proposed standard ohm and the unit of resistance originally determined by the British Association, and have also stated its relation to the mercurial standard adopted by the International Conference 9. We find that considerations of practical importance make it undesirable to adopt a mercurial standard. We have therefore preferred to adopt a material standard constructed in solid metal. 10. It appears to us to be necessary that in transactions between buyer and seller a legal character should henceforth be assigned to the units of electrical measurement now suggested, and with this view that the issue of an Order in Council should be recommended, under the Weights and Measures Act, in the form annexed to this report.

Specification referred to in Resolution 10.

In the following specification the term silver voltameter means the arrangement of apparatus by means of which an electric current is passed through a solution of nitrate of silver in water. The silver voltameter measures the total electrical quantity which has passed during the time of the experiment, and by noting this time, the time-average of the current; or if the current has remained constant, the current itself can be reduced. In employing the silver voltameter to measure currents of about one ampere the following arrangements should be adopted. The cathode on which the silver is to be deposited should take the form of a platinum bowl not less than 10 cm. in diameter, and from 4 cm. to 5 cm. in depth. The anode should be a plate of pure silver some 30 square centimetres area and 2 mm. or 3 mm. in thickness. This is supported horizontally in the liquid near the top of the solution by a platinum wire passed through holes in the plates at opposite corners. To prevent the disintegrated silver which is formed on the anode from falling on to the cathode, the anode should be wrapped round with pure filter paper, secured at the back with a little sealing-wax. The liquid should consist of a neutral solution of pure silver nitrate, containing about 15 parts by weight of salt to 85 parts of water. The resistance of the voltameter changes somewhat as the current passes. To prevent those changes having too great an effect on the current, some resistance besides that of the voltameter should be inserted in the circuit. The total resistance of the circuit should not be less than 10 ohms.

Method of Making a Measurement.

The platinum bowl is washed with nitric acid and distilled water, dried by heat, and then left to cool in a dessicator. When thoroughly dry it is weighed carefully. It is nearly filled with the solution, and connected to the rest of the circuit by being placed on a clean copper support, to which a binding screw is attached. This copper support must be insulated. The anode is then immersed in the solution so as to be well covered by it and supported in that position; the connections to the rest of the circuit are made. Contact is made at the key, noting the time of contact. The current is allowed to pass for not less than half-an-hour, and the time at which contact is broken is observed. Care must be taken that the clock used is keeping correct time during this interval. The solution is now removed from the bowl, and the deposit is washed with distilled water, and left to soak for at least six hours. It is then rinsed successively with distilled water and alcohol, and dried in a hot-air bath at a temperature of about 160 deg.C. After cooling in a dessicator it is weighed again. The gain in weight gives the silver deposited. To find the current in amperes, this weight, expressed in grammes, must be divided by the number of seconds during which the current has been passed and by ·001118. The result will be the time-average of the current, if during the interval the current has varied. In determining by this method the constant of an instrument the current should be kept as nearly constant as possible, and the readings of the instruments taken at frequent observed intervals of time. These observations give a curve from which the reading corresponding to the mean current time-average of the current can be found. The current, as calculated by the voltameter, corresponds to this reading.

Provisional Memorandum on the Preparation of Clark's Standard Cell.

Definition of the Cell.

The cell consists of zinc and mercury in a saturated solution of zinc sulphate and mercurous sulphate in water, prepared with mercurous sulphate in excess, and is conveniently contained in a cylindrical glass vessel.

Preparation of the Materials.

1. *The Mercury.*—To secure purity it should be first treated with acid in the usual manner, and subsequently distilled in vacuo.

2. *The Zinc.*—Take a portion of a rod of pure zinc, solder to one end a piece of copper wire, clean the whole with glass paper, carefully removing any loose pieces of the zinc. Just before making up the cell dip the zinc into dilute sulphuric acid, wash with distilled water, and dry with a clean cloth or filter paper.

3. *The Zinc Sulphate Solution.*—Prepare a saturated solution of pure—"pure recrystallised"—zinc sulphate by mixing in a flask of distilled water with nearly twice its weight of crystals of pure zinc sulphate, and adding a little zinc carbonate to neutralise any free acid. The whole of the crystals should be dissolved with the aid of gentle heat—*i.e.*, not exceeding a temperature of 30deg. C., and the solution filtered, while still warm, into a stock bottle. Crystals should form as it cools.

4. *The Mercurous Sulphate.*—Take mercurous sulphate, purchased as pure, and wash it thoroughly with cold distilled water by agitation in a bottle; drain off the water and repeat the process at least twice. After the last washing, drain off as much of the water as possible. Mix the washed mercurous sulphate with the zinc sulphate solution, adding sufficient crystals of zinc sulphate from the stock bottle to ensure saturation, and of small quantity of pure mercury. Shake these up well together to form a paste of the consistence of cream. Heat the paste sufficiently to dissolve the crystals, but not above a temperature of 30 per cent.; keep the paste for an hour at this temperature, agitating it from time to time, then allow it to cool. Crystals of zinc sulphate should then be distinctly visible throughout the mass; if this is not the case add more crystals from the stock bottle, and repeat the process. This method ensures the formation of a saturated solution of zinc and mercurous sulphates in water. The presence of the free mercury throughout the paste preserves the basicity of the salt, and is of the utmost importance. Contact is made with the mercury by means of a platinum wire about No 22 gauge. This is protected from contact with the other materials of the cell by being sealed into a glass tube. The ends of the wire project from the ends of the tube; one end forms the terminal, the other end and a portion of the glass tube dip into the mercury.

To Set up the Cell.

The cell may conveniently be set up in a small test tube of about 2 cm. diameter, and 6 cm. or 7 cm. deep. Place the mercury in the bottom of this tube, filling it to a depth of, say, 1 5 cm. Cut a cork about 15 cm. thick to fit the tube; at one side of the cork bore a hole through which the zinc rod can pass tightly; at the other side bore another hole for the glass tube which covers the platinum wire; at the edge of the cork cut a nick through which the air can pass when the cork is pushed into the tube. Pass the zinc rod about 1 cm. through the cork. Clean the glass tube and platinum wire carefully, then heat the exposed end of the platinum red hot, and insert it in the mercury in the test tube, taking care that the whole of the exposed platinum is covered. Shake up the paste, and introduce it without contact with the upper part of the walls of the test tube, filling the tube above the mercury to a depth of rather more than 2 cm. Then insert the cork and zinc rod, passing the glass tube through the hole prepared for it. Push the cork gently down until its lower surface is nearly in contact with the liquid. The air will thus be nearly all expelled, and the cell should be left in this condition for at least 24 hours before sealing, which should be done as follows. Melt some marine glue until it is fluid enough to pour by its own weight, and pour it into the test tube above the cork, using sufficient to cover completely the zinc and soldering. The glass tube should project above the top of the marine glue. The cell thus set up may be mounted in any desirable manner. It is convenient to arrange the mounting so that the cell may be immersed in a water bath up to the level of, say, the upper surface of the cork. Its temperature can then be determined more accurately than is possible when the cell is in air.

CITY NOTES.

Brazilian Submarine Telegraph Company.—The receipts for the past week were £5,279.

Great Northern Telegraph Company.—The receipts for the month of August were £23,600.

Commercial Cable Company.—The Company announce the payment, on October 1, of the usual quarterly dividend at the rate of 7 per cent. per annum.

Western and Brazilian Telegraph Company.—The receipts for the week ended Sept. 4, after deducting 17 per cent. of th gross receipts payable to the London-Platino Brazilian Company, were £3,565.

Cuba Submarine Telegraph Company. – The estimated traffic receipts for the month of August were £3,000, as compared with £2,913 in the corresponding month of last year.

City and South London Railway. – The receipts for the week ending (and including Sunday) 6th inst., were £671. 13s. 11d., against £716. 19s. for the week ending August 30.

Companies of the Month. – The following electrical companies have been registered during the past month :

	Capital.
British Electro-Chemical Agency, Limited, £10 shares ...	£75,000
Energy, Gas, Electric Lighting, and Power Company, Limited, £1 shares ...	20,000
Oxford Electric Company, Limited, £5 shares ...	100,000

NEW COMPANIES REGISTERED.

Heaths, Limited. – Registered by Dunn and Duncan, 87, Chancery-lane, W.C., with a capital of £50,000 in £10 shares. Object : to develop and carry out a system of displaying advertisements invented by Henry Heath, and to carry on business as advertising agents ; also as builders, woodworkers, metal founders, gas and electric light producers and suppliers, etc. The first subscribers are :

	Shares.
J. Clegg, Castleton, Manchester ...	1
A. H. Pownall, 89, Princess-street, Manchester ...	1
R. Okell, 62, King-street, Manchester ...	1
J. Clegg, Stonleigh, High Crompton, near Oldham ...	1
J. Henshaw, 5, Haworth's-buildings, Cross-street, Manchester	1
P. Higson, 69, Princess-street, Manchester ...	1
H. Foster, 69, Princess-street, Manchester ...	1

There shall not be less than three nor more than seven Directors. The first shall be appointed by the signatories to the memorandum of association. Qualification, £250. Remuneration to be fixed by the Company in general meeting.

PROVISIONAL PATENTS, 1891.

AUGUST 31.

14663. **Improvements in couplings for connecting electric wires.** Alexander Shiels, 70, Wellington-street, Glasgow.

14702. **Improvements in or connected with accumulators or secondary batteries.** Henry Hauser, 55, Chancery-lane, London.

SEPTEMBER 1.

14752. **Improvements in appliances for use with incandescence lamps.** Arthur Heald, Broad-street House, London.

14754. **New or improved apparatus for electrically indicating the overheating of bearings.** Bernard Page Scattergood, 38, Chancery-lane, London.

14764. **Improvements in armatures for dynamo-electric generators and electric motors.** William Phillips Thompson, 6, Lord-street, Liverpool. (James Francis McLaughlin, United States.) (Complete specification.)

14768. **Improvements in lightning arresters.** William Phillips Thompson, 6, Lord-street, Liverpool. (James Perry Freeman, United States.) (Complete specification.)

14780. **Improvements relating to telegraphy.** Benjamin Burdwood Toye, 106, Victoria-chambers, Chancery-lane, London.

14790. **Improvements in electrical switches.** Walter Poynter Adams, Springwell, The Terrace, Barnes.

14794. **Improvements in percussion drills and other percussion tools worked by electricity.** Siemens Bros. and Co., Limited, 28, Southampton-buildings, London. (Siemens and Halske, Germany.)

14796. **Electric meter for continuous or alternating currents, also applicable as speed indicator and speed regulator.** Charles Denton Abel, 28, Southampton-buildings, London. (La Compagnie Anonyme Continentale pour la fabrication des Compteurs à Gaz et autres appareils, France.) (Complete specification.)

14800. **Improvements in and relating to electric metal working apparatus.** Henry Harris Lake, 45, Southampton-buildings, London. (Hermann Lemp, United States.)

SEPTEMBER 2.

14817. **Improvements in and connected with electric tramcars.** William Edwin Heys, 70, Market-street, Manchester. (Charles Brown, France.)

14834. **Improvements in and connected with electrically-propelled vehicles.** William Edwin Heys, 70, Market-street, Manchester. (Charles Brown, France.)

14854. **Improvements in materials for insulating electrical conducting wires, and for making carbons and incandescent filaments for electric lighting.** Gustave Adolphe Cannot, 35, Southampton-buildings, London.

14859. **An improvement in incandescent electric lamps.** Edward Alfred Gimingham, 28, Southampton-buildings, London.

SEPTEMBER 3.

14874. **An improvement in electric light switches.** R. H. Newington and E. Priddle, 4, Berry-street, Clerkenwell, London.

14911. **Telephone receiver supports.** William Nathaniel Marcus, 97, Newgate-street, London. (Date applied for under Patents Act, 1883, Sec. 103, 10th February, 1891, being date of application in United States. (Complete specification.)

14912. **Telephone mouth-pieces.** William Nathaniel Marcus, 97, Newgate-street, London. (Date applied for under Patents Act, 1883, Sec. 103, 10th February, 1891, being date of application in United States.) (Complete specification.)

14916. **Improvements in magnetic separators.** Thomas William Arnold, 88, Colmore-row, Birmingham.

14920. **Improvements in insulators for telegraph and other wires.** Karl Schmaus, 18, Buckingham-street, London.

SEPTEMBER 4.

14962. **Improvements relating to telephones.** William Henry Brown, 8, Quality-court, London. (Complete specification.)

14967. **Improved process and apparatus for extracting aluminium and its alloys by electrolysis.** Georg Steinle, 57, Chancery-lane, London.

14987 **Improved electrical drill.** Siemens Bros. and Co., Limited, Alfred Herbert Dykes, and Francis Gibson Baily, 28, Southampton-buildings, London.

SEPTEMBER 5.

15014. **An improved electric belt or band.** Walter Northcott Naylor, 21, Finsbury-pavement, London.

15025. **An improved apparatus for propelling one or more imitation birds by electricity for shooting at.** Archibald McLean Gordon, and Edmund Kelly Irwin, 89, Wigmore-street, Cavendish-square, London.

15050. **Improvements in or connected with electrolysis.** Ernest Arthur Le Sueur, 47, Lincoln's-inn-fields, London.

15051. **Improvements in medical electric appliances.** Charles Spilsbury Stovin, 2, Victoria-mansions, Westminster, London.

15052. **Improvements in medical electric appliances.** Charles Spilsbury Stovin, 2, Victoria-mansions, Westminster, London.

SPECIFICATIONS PUBLISHED.

1883.

3452. **Secondary batteries.** Lyte. (Second edition.) 4d.

1889.

6675. **Electrically-driven fans.** Watel. (Second edition.) 6d.

1890.

350. **Galvanic batteries.** Epstein. (Second edition.) 8d.

12440. **Electric testing apparatus.** Day and Dowsing 1s. 1d.

12957. **Electric lighting by coin-freed apparatus.** Davies and Tourtel. 8d.

12958. **Producing electric light by insertion of coin.** Davies and Tourtel. 8d.

13357. **Electromotors.** Siemens. 6d.

15573. **Attaching electric fittings, etc.** Down. 6d.

15635. **Commuting alternating electric currents, etc.** Hall. 8d.

15643. **Electric tramways.** Hopkinson. 8d.

16054. **Electric batteries.** Serrin. 8d.

16055. **Electric batteries.** Serrin. 8d.

16156. **Electric conductors.** Johnstone. 8d.

16278. **Electrical conductors.** Walton and Edmunds. 4d.

16347. **Electric clutches.** Willans. 6d.

16399. **Electric deposition of metals.** Boult. (Joray.) 8d.

1891.

2642. **Telephone receiving instruments.** Mercadier. 8d.

7204. **Electric alarms.** Kingsland. 8d.

7762. **Reciprocating electric engines.** Van Depoele. 8d.

9073. **Electric railways.** Munsie. 8d.

9240. **Incandescent gas-burners.** Boult. (Chemin.) 8d.

11746. **Telegraphic apparatus.** Van Houten. 11d.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Brush Co. ...	—	2¼
— Pref. ...	—	2
India Rubber, Gutta Percha & Telegraph Co. ...	10	19¾
House-to-House ...	5	5
Metropolitan Electric Supply ...	—	10
London Electric Supply ...	5	1¼
Swan United ...	3¾	1½
St. James' ...	—	6¼
National Telephone ...	5	4½
Electric Construction ...	10	[illegible]
Westminster Electric ...	—	[illegible]

NOTES.

Tangiers Cable.—The inauguration of the cable from Tangiers to Tarifa took place on Tuesday.

Chatham.—The Chatham town councillors are thinking of having the Council room lighted by electric light.

Old Students' Association.—Mr. W. B. Esson has been again nominated as the president-elect of the Old Students' Association.

Ipswich.—The arc light which the Ipswich Lighting Committee agreed to pay £15 a year to Messrs. Fraser, was started last Friday.

Glasgow.—Negotiations are pending by which the Glasgow Corporation is to buy the electric central station of Messrs. Muir and Mavor.

Electric Railways in Russia.—The first electric railway in Russia is being constructed at Kiev by the Allgemeine Electric Company of Berlin.

Dundee.—As will be seen by the full report elsewhere, the Dundee Gas Commission has resolved to spend £15,000 to £20,000 on a preliminary electric central station.

Darwen.—The Town Council of Darwen are spending £10,000 on improving their town. The present might be a favourable moment for introducing the electric light.

Paris National Library.—It is hoped that the Bibliothèque Nationale at Paris may be lighted by electricity during the coming winter. The Budget grant, however, has not yet been made.

Bradford.—At the Bradford Town Council meeting last week, Alderman Priestman stated that there was a loss of £30 on the working of the electric lighting department in the last half-year. He had no doubt that next half-year's working would yield a profit.

Electric Traction at Madrid.—The question of electric traction on the tramways is occupying much attention at Madrid, we understand. It is reported by the Spanish papers that one of the four tramway companies of Madrid is intending to instal the Gordon closed conduit system.

Malvern.—At the Malvern Local Board on Tuesday, a letter was received from Messrs. Griffiths and Millington, of Worcester, asking upon what terms the Board would be prepared to grant the right which had been obtained to supply the electric light. The decision upon the question was deferred.

Hand Dynamos.—We notice a neat and simple arrangement of hand dynamo made by Societa Elettrica Industriale, of Milan, which can be used for lecture experiments for charging small accumulators, lighting small lamps, or driving small motors. It is of inverted magnet type, giving opportunity for inspection of armature.

Testing Cables.—We notice that a useful work, entitled "A Practical Guide to the Testing of Insulated Wires and Cables," by Herbert Lawes Webb, member American Institute of Electrical Engineers, and of the Institution of Electrical Engineers, London, after having been published in America, is being also published in this country by Messrs. Spon.

Accident on the Portrush Electric Railway.—Two trams got upon the same line on the Giant's Causeway electric tramway last Saturday morning, and thinking the cars were going to collide, Mr. Hall and his wife, of Halifax, jumped from the car. The cars were stopped just as they touched. The lady was seriously injured, and the drivers were immediately arrested.

Tiverton.—At the meeting of the Tiverton Town Council last week, Mr. Grason said he was sorry the report of the Electric Lighting Committee had not yet been prepared, but it would be in their hands before the next meeting. Meanwhile it was thought desirable that the whole of the Council should pay an official visit to the electrical engineering exhibition at Taunton.

Munich.—The builder of the Cassel electricity works, Herr von Müller, has laid before the Munich municipal authorities his project for the utilisation of the water power of the Isar for electrical purposes. A preliminary force of 1,200 h.p. can be obtained, which will be used to produce rotary currents of 2,000 volts pressure. It is proposed to put transformers in each factory for alternate-current motors as well as light.

Electric Hand Fan.—Mr. William Luce, of Boston, is introducing a neat little invention for the ladies—a pendant to the electric cigar lighter—in the shape of an electric hand fan. The wings fold up and slip in the handle; on unfolding and connecting to a wall socket, pressure on a little knob sets the tiny fan rotating and sending "a gentle breeze to cool the glow of beauty's o'erflushed cheek."

Bradford Municipal Buildings. — Tenders are invited for carrying out works required in connection with the lighting by electricity of certain rooms in the Municipal Buildings, for the Bradford Corporation. Plans and specifications may be seen at the office of Mr. W. T. M'Gowen, town clerk, Town Hall, Bradford. Sealed tenders, endorsed "Tender for Electric Lighting," to be forwarded to the town clerk by 28th inst.

Proposed Electrical Exhibition in Glasgow.—The success which attended the Industrial Exhibition recently held in the East End of Glasgow had led to the suggestion, says the *Scotsman*, that an electrical engineering exhibition should be promoted in the same building during the winter months, and a prospectus has been issued setting forth the nature of the articles to be shown. One of the principal attractions would be Buffalo Bill's Wild West Show, which in any case will visit the district in November and remain till February.

Cologne.—The electric distribution from the new central station at Cologne is by alternate currents and transformers. The cables are buried in asphalte poured into wooden conduits. Herr Hegener, the director of this station, is greatly in favour of transformers as against accumulators. He states, in illustration of his views, that the efficiency of the accumulators in the Darmstadt station has dropped from 62·1 to 57·8 per cent. within a year. It is clear, however, that differences of manipulation might cause such variations from one year to another.

New Zealand. — The Town Council of Launceston, Tasmania, it is stated, proposes to introduce the electric light at an estimated cost of £50,000, to be generated by water power at a distance of some three miles. The town has obtained an Electric Light Act, in which the curious provision is inserted that the cost of electric supply, both for public and private purposes, may be met by a rate, not to exceed 7 per cent., in the way the water supply is paid for in this country. Where the current is not used, or is not available, the rate is to be reduced to one-fourth.

Electric Mining in South Africa.—A proposal has been made to use electric transmission of power at the

Eureka Mine of the Victory Hill Consolidated Mining Company, South Africa. Both mine and mill would be furnished with all the light and power necessary for working It is proposed to lay down a 100-h.p. plant, 60 h.p. of which would be delivered at the power station at the mine. The power would be obtained from turbines placed near the junction of the Golden Valley stream with the Kaap river. Water enough for the plates of a 25 stamp-mill would be available.

St. Helens.—At the monthly meeting of the St. Helens Town Hall Committee, on Wednesday, the question of lighting the Town Hall by electricity was discussed at great length. Councillor Martin had suggested that the surveyor should get out specifications and ask for tenders for the lighting of the Town Hall on an alternative plan. In the first place, tenders might be obtained for the lighting of the whole of the buildings, with the exception of the police station; and in the second place for the lighting of assembly-room, Council-chamber, and the committee-rooms only. This suggestion was unanimously adopted.

Automatic Speed Counter.—A neat little instrument has been devised by M. Redier to overcome the difficulties and troubles usually experienced in taking the speed of axles. No seconds watch is required, and no attention is needed. The counter contains two hands, a simple set of watch gear, and a counter. The hands are brought to zero, and the gear wound up, and the first hand set for the time required—one minute, 30 or 15 seconds. The triangular sharp steel end of the counterwheel is placed to the axle to be tested. This starts the mechanism, counts the turns, and the hand is automatically stopped at the end of the time, showing exactly the number of revolutions.

Telephone.—Messrs. Whittaker are about to publish a practical handbook on the telephone, dealing specially with telephonic exchanges, by Mr. Joseph Poole, of Manchester, who has been connected with these exchanges since their first establishment in this country. The subject is of particular interest at the present time on account of the expiration of the master telephone patents and the consequent great extension likely to take place in telephonic installations. The book is intended to supply the existing want of a thoroughly practical manual, of moderate size and cost, describing the latest developments of the subject and suitable for the requirements of telephonic employés and users of the telephone.

Middlesbrough. — At last week's meeting of the Middlesbrough County Council, Mr. J. A. Jones moved, "That the time has arrived for the Corporation to take steps to introduce the electric light into Middlesbrough for the benefit of the people." He said if the electric light was introduced, the gas works would be wanted just the same as ever. Something like £20,000 in expenditure on electric machinery would give them something like 2,000 incandescent lights. He mentioned London and other towns where the electric light was working successfully. Councillor Hinton seconded the resolution. After debate, Alderman Archibald moved that the matter be referred to the General Purposes Committee. Alderman Archibald's amendment was seconded by Councillor McLarchlan, and agreed to.

Bodmin Town Council.—At a meeting of the Bodmin Town Council, held on Tuesday last week, the Mayor (Mr. J. R. Collins) presiding, the Lighting Committee's report was considered. At the previous meeting of the Council the question of illuminating the streets with the electric light came on, and the town clerk was directed to write for prices. The subject when again raised was received with derisive laughter, but, when the replies were read, it proved that the electric lighting of the streets would cost considerably less than gas. The matter was referred to the Lighting Committee, who it is hoped will do all in their power to bring the matter to a successful issue. The suggestion is, however, resented by many of the councillors, who are said to be shareholders in the Bodmin Gas Company. The usual contract for gas lighting was approved.

Sheffield.—At the meeting of the Sheffield County Council, last week, a resolution was carried by 24 votes to 19, to the effect that before the Parliamentary Powers Committee enter upon any detailed examination of the terms of any company, or make any agreement with any company with respect to the supply of electricity to Sheffield, they shall have the definite instructions of the Council as to whether they will or will not themselves apply for a provisional order authorising them to supply electricity in the borough under the Electric Lighting Acts. The opinion of the majority was that it would be better if satisfactory arrangements could be made to allow a company to make application for the order, whereas the minority wished the Council to at once take the necessary steps for applying for the order and afterwards to supply the light to the town.

Teignmouth.—The people of Teignmouth are in the position of requiring an extension of lighting facilities. It has been proposed to lay additional gas mains, and at the meeting of the Local Board on Tuesday the question was discussed. It was proposed to reduce the rate for gas from 4s. 2d. to 3s. 9d. per 1,000 cubic feet. Mr. Stooke thought that the electric light should be introduced before this arrangement was carried out; the gas works would then be sufficient. The chairman said he had had correspondence with an electric light company, and the manager had promised to come over and see what machinery would be required if a station were started. It was finally decided that the price should be reduced and that £6,000 be spent in extensions. The electric light was further discussed, and it was decided to ask the electric light company to explain to the Board the probable cost of a station.

Chicago.—The construction of the buildings for the Chicago Exhibition is being rapidly pushed forward. The ground enclosed in a fence six miles long is a huge workground, with waggons on all sides, and teeming with workmen. The large buildings are beginning to rise. The foundations of the electricity and mines and mining buildings are already completed. Upon the sites of the horticultural and transportation buildings all preliminary work is completed, and hundreds of tons of material are ready to be placed in position. Hundreds of men are engaged on every possible sort of construction work—laying water mains, electric light plant, modelling for the exterior decorative work and developing landscape effects around the ornamental waters. The exposition ground will soon be as busy by night as by day, as arrangements have just been made for the electric lighting necessary for night construction.

Richard's Arc Light Carbon.—It will be remembered that the arc light carbon of Mr. Saunderson, which we described some time ago, had an asbestos wick conducting an hydrocarbon liquid or vapour into the arc. In this case the wick was on the inside of the carbon. This carbon presented some considerable advantages in higher luminosity, but the practical advantages, at any rate, have not yet succeeded in getting it put upon the market. The disadvantages of the Saunderson carbon may be to some extent obviated in the simple arrangement proposed by Mr. Walter S. Richards, of Natick, Massachusetts, who merely runs a wick of mineral wool outside the carbon, bound thereto by fastenings of wire. A thimble of liquid hydrocarbon is placed at the bottom of the carbon, which mounts by capillary attraction, and as the wick is exposed to the air the whole way, it is only attacked by the heat at the immediate point where the arc is formed.

Electric Trolley Rods.—Considerable difficulty has been experienced in designing for overhead electric tram lines a trolley rod, which shall bend up and down, to the right or left without leaving contact, and at the same time to be cheap and simple. Scores of designs of various principles have been made, especially on American lines, where the demand is greater than in England, embodying all kinds of springs and counterbalance movements. But nothing simpler or cheaper, as far as we are aware, has been proposed than that used on the Schuckert overhead conductor tram line at the Frankfort Exhibition, which consists simply of an ordinary coiled conical spring (such as is made by slitting a metal tube spirally), one end fixed to the roof of the car and the other bearing a socket for the trolley rod. This arrangement has no need of adjustments, is perfectly flexible, and gives no trouble whatever. It should supersede the complicated aggregation of springs sometimes advocated.

Canadian Cables.—The telegraphic system of one section of the empire has of late been undergoing marked development. Mr. Hosmer, the manager of the Canadian Pacific telegraph system, was in Europe recently, and it is now announced, says the *Financial News*, that while here the controlling interest in the Halifax and Bermuda cable was secured by a Canadian syndicate in which friends of the Canadian Pacific Railway Company figure largely. The result will be, Mr. Hosmer says, the laying of some 1,200 miles of additional cable in the near future, while a very material reduction will be brought about in the almost prohibitory rates between the West Indies and Canada, the United States and Europe. "Thus," says Mr. Hosmer, "the system will supplement the Candian Government policy to cultivate trade with the West Indies; for cheap telegraphic rates cannot do otherwise than promote closer and more extensive business relations with the Canadian Dominion.

Dundee Infirmary.—On Monday a quarterly court of the governors of the Dundee Royal Infirmary was held in the Town House Buildings. The chairman (Mr. Thos. Maitland) said at the last meeting the governors sanctioned the introduction of electric light to the infirmary, at an estimated cost of about £300. On approaching the matter more closely, the directors found that the estimate included only the provision of sufficient power to provide for the lights which were now necessary. They thought it wise to have some reserve power. It would cost comparatively little—about £65—as they had sufficient engine and boiler power. He moved the following resolution, which was seconded by Mr. J. C. Keiller, and unanimously carried: "With reference to the electric lighting of certain parts of the house at an estimated cost of £285, authorised at last annual court, the governors approve of and authorise the acceptance of a larger size of engine and dynamo than originally estimated for, so as to allow of additional lights, at a further estimated cost of £65."

The Lauffen Transmission.—The further particulars with reference to the transmission of power from Lauffen to Frankfort (from the *Times*, given elsewhere) will be interesting pending full details of tests, which will doubtless be forthcoming shortly. The current supplies at present 1,200 glow lamps, of which part are arranged in letters "Lauffen Kraftübertragung"— (Lauffen transmission of power); the remainder of the power drives a centrifugal pump for a waterfall 33ft. high. The efficiency is stated as 75 per cent., but this is evidently a rough estimate. Exact details when the full pressure of 25,000 volts, and the full power of 300 h.p. are transmitted, will be awaited with interest. It may not be out of place to state that the English agents of the Allgemeine Electric Company, whose plant is used in this memorable installation, are the Keys' Electric Company, of Charing Cross-road, London, in whose premises a small installation on this system will be exhibited within a few weeks. Mr. Reckenzaun is now in Frankfort to conduct tests, and to arrange for the bringing over of sample plant.

Hove (Sussex).—As will be seen by the advertisement elsewhere, the Hove Commissioners are prepared to receive proposals from companies or persons willing to take over the undertaking and statutory powers for the supply of electrical energy in Hove vested in the Commissioners by the Hove Electric Lighting Order, 1890. The provisions to be dealt with in such proposals, which include the erection of the necessary buildings, works, and machinery, and the laying down of the distributing and other mains, the price to be charged for electrical energy supplied as well for public purposes as to private consumers, terms for sale of undertaking to the Commissioners at a given period, and other particulars, may be obtained at the town clerk's office, Town Hall, Hove, on payment of £5. 5s., which will be refunded on a proposal being sent in. The Hove Electric Lighting Order, 1890, may also be seen at the Town Hall. Proposals, addressed to the town clerk, Town Hall, Hove, and endorsed "Proposals for Electric Lighting," will be received up to the 26th day of October next.

Inverness.—At a meeting of the Inverness Police Commissioners, on Monday, Bailie Jonathan Ross directed attention to the report of the gas manager, in which he stated that owing to the yearly increasing consumption of gas in the town additional machinery and holders would be required at the gas works, and he estimated the cost at about £10,000. Before embarking on such a heavy expenditure, Bailie Ross thought the Commissioners should consult an engineer on the subject of lighting the town by electricity. It had been suggested that the necessary motive power might be obtained from the river or from Loch Ness, or even from the Fall of Foyers. He thought, however, a committee should be appointed to make full enquiry into the whole subject of electric lighting, with power to consult a practical engineer, and to bring up a report as to the probable cost. Ex-Bailie M'Bean, who seconded, expressed the opinion that the town could at least light all the principal streets and public buildings by electricity at a less cost than that estimated for the construction of additional works at the gas works. The motion was unanimously adopted.

Electric Heaters.—Heating by means of electricity has not yet elevated itself into the sphere of "practical politics" in England, though in the States electric heaters are used in the electric railway cars. The kind there used is that devised by Dr. Burton, depending on the well-known generation of heat by direct resistance to current. This method has, however, one scientific objection, in that a large current is required to warm the resistance wires in the heater, and a large current also heats the conducting wires. Mr. Guttmann in his electric heater contrives to obtain great heating effect, with small current, by using alternating currents of high tension, passed into a magnet, whose pole is placed just beneath the plate of the cooking stove. The rapid alternation of polarity in the iron soon, together with the generation of secondary eddy currents of great quantity, generates heat, and the plate may be kept sufficiently hot to boil water or cook food. As the maximum heat is generated at the lower surface, the plate is pierced with air holes; the top of the magnet poles are also protected from heating. Mr. Guttmann shows an electric stove lined with brick, any chamber or plate of which can be immediately heated up to any desired temperature by turning and adjusting the switches.

Chislehurst.—The Chislehurst Parochial Committee on Monday again discussed the proposal of the Electric Lighting Supply Company, with respect to obtaining a provisional order. If the order is obtained several large property owners will fix the electric light to the houses owned by them. Mr. R. G. Mullen said if the company were allowed to obtain a provisional order they would have a monopoly throughout the parish. This had been the view which had actuated the Bromley Local Board, of which he was clerk, in obtaining the powers for themselves, in order that they should have some control over the lighting of their district. If the local authority applied there would be an expense of about £100 in printing, and about £50 in House of Commons expenses. That would be all if the application were not opposed, and their own officials acted as in the case at Bromley. The consideration of the matter was adjourned until the next monthly meeting, in order that every member might be present. An agitation has commenced at Sidcup for the electric light, and as Sidcup is a town carved out of the parishes of Chislehurst, Foots Cray, Bexley, and Eltham, it comes under the same central body—the Bromley Rural Sanitary Authority—who will have to obtain the provisional order, should the local committees decide in favour of so doing.

Plymouth.—At the Plymouth Town Council meeting last week, Mr. F. W. Harris moved the adoption of the report of the Works Committee, which contained the following amongst other recommendations: "That Messrs. F. W. Harris, Cuming, Bray, Lapthorn, Kerswill, and Lethbridge be appointed a sub-committee to confer with the engineer of the Devon and Cornwall Electric Lighting Company with reference to the lighting of the borough with electric light. That tenders be invited for the lighting of the borough." In reply to questions, Mr. Harris said the committee would be glad of any assistance from the Electric Lighting Committee in the matter of the arrangements with the Devon and Cornwall Electric Lighting Company. He understood that another communication had been received from the company, and that it, together with further information from the surveyor, would be laid before the committee. A correspondent to the *Western Morning News* suggests the utilisation of the water power in the town. He points out that there is a good fall at Drake's-place, at the King's Mill site, and the old Providence Mill site, all belonging to the town. There need be no difficulty at all in piping it to convey the water to the sites. The town would thus save the cost of steam power, and as the plant would only be worked by night, waste water not required by the inhabitants would be used, which would thus help to lighten the rates.

Derby Industrial Exhibition.—During the past month an industrial exhibition has been held at the Drill Hall, Derby, where electrical appliances were exhibited by Messrs. John Davis and Son, of Derby, and the National Telephone Company. In the engine-room at the entrance were some four or five engines at work, and here Messrs. Davis exhibited an 18-unit compound-wound dynamo, driven by a "Trent" gas engine; this dynamo was used for lighting the hall and stage with incandescent lamps of from 16 c.p. to 500 c.p. A 2½-unit dynamo, driven by another engine, was used to work a motor for an automatic grain-weigher, an engraving machine, and a ventilating fan placed in the hall; the whole plant worked perfectly from the beginning. On Messrs. Davis's stand in the hall were exhibited a large variety of telephones, mining bells, and Keys' portable primary and secondary lamps (one of which for use in mines gives 1½ c.p. for 10 hours and weighs 3½lb.), and an extensive assortment of their well-known dust-proof fittings for mines, iron works, ships, etc. They also showed their new electric workman's time check, worked by hand or by a clock from the foreman's office, and numerous other handy applications of electricity. Their exhibits as a whole comprised the greater number of the departments of electrical engineering, and has obtained the gold medal, as was the case at the mining exhibition of last year.

Electric Street Cars.—Mr. Walter M. Galbraith, writing to the *Glasgow Herald* upon the subject of the introduction of electric cars into that city, says, with reference to their extensive use in America, "I visited the States in spring, travelling right across the Continent to the Pacific, and I had ample opportunity of testing and comparing the American system of street cars with our own, and it requires no very practical electrician to see that we are about as far behind 'Brother Jonathan' in this respect as we possibly can be. The objection has been raised that electric cars are not adapted for steep gradients, such as Renfield-street or New City-road, in Glasgow. But this is quite a mistake. I spent a Sunday in Tacoma, which is built on a very steep slope, most of the streets being quite as precipitous as those leading up to Garnethill, and I watched with great interest the electric car going up and down the steep incline, and no one but myself seemed to be aware that there was any danger, as there was absolutely none beyond that which existed in my own imagination. As regards speed, this can be regulated to the district and in accordance with the traffic, but it must be apparent to all that it is an immense advantage to be able to run the cars rapidly, say, up to a speed of eight to ten miles an hour, if required, and not be, as at present, bound down to the orthodox four miles an hour, with something considerably less when the car is heavily loaded. In Victoria, B.C., the electric cars run right into the country, and go at a rate which allows gentlemen to go home at midday, 10 minutes being sufficient to take them to their destination. The car runs out to Esquimault, so that the evening can be spent in the country, far away from all temptation, and still you can be landed at your own door without experiencing the fatigue and excitement connected with railway travelling." Another correspondent suggests that an exhaustive report should be obtained on this subject from Sir W. Thomson and the president of the Institution of Engineers in Glasgow.

Birmingham Town Hall.—An installation of some importance in Birmingham, that of the Town Hall, has just been put to a preliminary trial in the presence of the committeemen, with satisfactory results. The Birmingham Town Hall was one of the first public places wherein the electric light was installed in the early days, but its prohibitive cost only allowed it to be used for demonstrative purposes. The present lighting has been carried out by Messrs. Winfield, from specifications by Mr. Henry Lea, M.I.C.E., electrical adviser to the Town Council, the current being obtained from the mains of the Birmingham Electric Supply Company. The lamps are suspended from the ceiling on large electroliers, principally two central pendants, one of 30 and the other of 24 incandescent lamps of 32 c.p. These supply sufficient light for ordinary occasions, but for fuller and more brilliant illumination they are supplemented by 16 smaller pendants of eight or 10 lamps each. A series of single lamps are also arranged under the galleries. The total number of lamps in the great hall is 224, equal to 6,880 c.p. The pendants, of classical design by Messrs. Winfield, carry frosted globes without shades. Each electrolier is suspended by steel wires in such a manner that it can be readily lowered for cleaning, repairs, or alteration in the number of lamps. They are hung 36ft. above the level of the floor. The installation extends to every part of the building, in all containing 425 lamps, of which 273 are of 32 c.p. and the remainder of 16 c.p. The size of cables adopted is very large, three pairs consisting of 61 strands of No. 11 wire, measuring outside insulation about 2in. diameter. This large size was adopted to keep the loss in the building to within two volts, of which ¼ volt only is allowed in the service mains. The main fuses and switches were supplied by the Electric Supply Company; the wiring was done by the Midland Electric Lighting Company, as sub contractors to Messrs. Winfield. The total cost of the installation is £1,500.

Electric Resistance of Metals.—M. Le Chatelier has proposed to characterise the varying molecular state of metals by the value of their electric resistance, and to determine by the same method the exact temperatures at which they pass from one state into another. At the point of transformation the resistance does not suddenly change, as does the volume, the latent heat, and the greater number of physical properties: the law of increment alone experiences a sudden change, giving an angular point on the representative curve. For iron and nickel the resistance, cold, and the law of increment are identical up to 340deg. C. At this temperature a sharp angle announces the well-known transformation of nickel. For iron, the corresponding transformation takes place at 850deg. C. Above each of these temperatures the curves of resistance are rectilinear and parallel. The transformation at 850deg. also takes place in carbon steel and silicium steel. This affords evidence in favour of the cellular theory of M. Osmond. The fixity of the point of transformation implies, in fact, the simple mechanical juxtaposition of pure iron with the carbide or silicide. In nickel steels, on the other hand, the transformation of the two metals takes place at a determined temperature for each alloy, intermediate between 850deg. and 340deg. For the various alloys tested this temperature varies between 400deg. and 600deg. C. Carbon steels gave a second angular point at the temperature of 730deg. C., corresponding to the transformation known under the name of recalescence. This point remains the same when the amount of carbon varies. The curves of electric resistance have not given any other indication of molecular transformation of iron and its alloys. It might not be impossible, however, that the loss of magnetic properties of iron and steel which, according to the experiment of M. Ledeboer and Dr. Hopkinson, take place at 760deg., correspond to a third molecular transformation, which would be the point $a p_2$ in M. Osmond's theory. This transformation may be prevented by the tempering, which is not the case, however, with the transformation of 850deg.

Blakey-Emmott Catalogue.—Halifax possesses, in the shape of Messrs. Blakey, Emmott, and Co., a firm whose electrical works are of considerable and growing importance. We are just in receipt of their catalogue, and from it gain some interesting details of the extent of the works. These are shown in one of the illustrations in the catalogue, and cover a total area of 1¼ acres, comprising a prinicipal works of seven floors and several outbuildings, in which all branches of the trade is carried on. The catalogue illustrates their well-known single-magnet "Blakey-Emmott" dynamo, made for all sizes up to 30,000 watts capacity. Above this size they are made of the four-pole type, The armatures on the two-pole machines are Gramme type, and in the four pole machines drum type, built up of charcoal iron discs carefully insulated. The cores are insulated with mica before being wound. The winding consists of one layer only. These dynamos make efficient motors and develop approximately the same brake horse-power as required to drive them as dynamos. The Blakey-Emmott alternator is a handsome machine, consisting of a huge ring (in two parts) with 14 internally pointing poles. The armature is simply a ring built up of iron discs, and mounted on a metal spider axle. Upon the surface of this armature the conductors are laid, there being no internal wires or crossings. The insulation is of mica, and the brushes are of carbon, on solid collector rings. The magnets are separately excited in the usual way. These alternators work well in parallel, and are usually made for 100 cycles per second. "Blakey-Emmott" transformers are shown —2,500 to 10 volts. The illustration of a model small central station plant already carried out, is given with particulars. Special combinations of engine and dynamo for restricted space, as on shipboard, are shown with vertical engine of moderate speed with slow-speed dynamo. Switches, main fuses, differential arc lamps, potential and current meters, Oulton and Edmondson's meters, and the "Blakey-Emmott" gas or petroleum engine also appears in the catalogue, from whence it is seen that the firm are in a position to supply entire electric light and power requirements of their own manufacture.

Concentric Wiring in Liverpool.—An important installation, in which Andrews's system of concentric wiring is used, has just been completed at the Waterloo Grain Warehouses, Liverpool, belonging to the Mersey Docks and Harbour Board. This system, which is already well known to most of our readers, has as its important feature the outer, or return conductor, made of iron uninsulated, forming a substantial protection to the insulation of the inner conductor of copper, and making, with the solid brass cases of the cut-outs, switches, etc., an unbroken conductor throughout. Switches and cut-outs act only on the centre wire. No wood casing whatever is required. The installation will be a favourable opportunity to demonstrate the merits of the system. The Waterloo Warehouses consist of three six-storey blocks, 80ft. wide, built along three sides of the Waterloo Corn Dock. The middle block is 180ft. long, and the side blocks are each 650ft. At intervals along the centre of each block hatchways for hoisting purposes reach from the quay level to the top of the building, and upon each of these a branch wire securely fixed in an angle-iron is carried, and conveys current to two sockets at each floor. Long lengths of steel-armoured flexible wire provided with couplings to fit these sockets are used for attaching the lamps. Each flexible wire supplies one 50-c.p. lamp, which can thus be moved about the room and placed in the most convenient position for working by, and a number of lamps can be grouped wherever a strong light is required. Similar sockets and flexible leads are arranged for carrying lights down into the holds of vessels lying in the dock, so that the trimmers on board may also have plenty of light for their work. The dynamo in connection with this installation is of Messrs. W. T. Goolden and Co.'s well-known make; it is driven by a belt from an engine of the inverted vertical marine type, steam being supplied by the main boilers used for the hydraulic system on the Dock Estate. The installation has been carried out to the specification of Mr. G. F. Lyster, the dock engineer, by Messrs. J. D. F. Andrews and Co., 41 and 42, Parliament-street, London, S.W., with the assistance of Mr. W. S. Boult, A.M.I.C.E., 60, Castle-street, Liverpool, their sole agent for Lancashire and Cheshire.

SOME ELECTRICAL WORDS.

A very fair idea of the rise and progress of a science may be gathered from a study of the technical terms which have been used from time to time to explain the various phenomena, or for the purpose of setting forth new theories. Should anyone be disposed to make such an attempt in regard to electricity, he will find the material ready to his hand in the recently-issued part (E—Every) of the "New English Dictionary on Historical Principles," a monumental work now in course of publication by the Oxford University Press. As there may be some who are unacquainted with this modern "Johnson," it is perhaps necessary to say that it is based, as the title sets forth, on strictly "historical principles." It is true that the definitions are generally in the editor's own words, but they are little more than a summing-up of the evidence furnished by quotations from authors of acknowledged repute, and as full references are always given, the reader can verify them for himself and obtain further information if he wishes for it.

The word "electricity" and the various compounds under "electro" occupy more than ten closely printed columns of small type, enough to more than fill an entire number of the *Electrical Engineer*. We do not advocate any radical reform in scientific nomenclature, but it is curious to observe what a vast superstructure has been built upon a foundation which is, logically speaking, utterly insecure. Every text-book tells us that "electric" is derived from a Greek word signifying "amber," that substance when rubbed developing electricity. But who thinks of amber in connection with the electrical science of the present day? The modern Latin word seems to have been first used by Gilbert, in 1600, in his treatise "De Magnete," and the earliest instance of its use in English is in Sir Thomas Browne's "Vulgar Errours" (1646). For "electrical" there is an earlier authority in Carpenter's "Gegoraphy Delineated" (1635). The editor notices the somewhat arbitrary uses of the words "electric" and "electrical," which are precisely synonymous, although we should not expect to be asked "Have you bought any electric books lately?" nor do we usually speak of the "electrical light."

Proceeding in alphabetical order we come upon "electricalness," a word we never met with before. The only authority for it is Bailey's Dictionary (1736), but we doubt if the word was ever actually used. We were rather surprised to learn that "electrician" dates as far back as 1751, when we find Franklin saying in the *Philosophical Transactions* "I have not heard that any of your European electricians have been able to . . . do it"—words which somehow or other have a familiar sound, as if we had heard them only the other day. "Electricity" is a long article, the earliest quotation being again from Sir Thomas Browne's "Vulgar Errours" (1646). The *Philosophical Transactions* furnish many examples, and the editor points out that the term "electric fluid" survives in popular language, and that "positive" and "negative," which we also inherit from Franklin's theory, are still in scientific use.

"Electric light," in its modern restricted sense, makes its first appearance in 1843, as the heading of a paragraph in the *Mechanics' Magazine*, "Electric Light a Substitute for Gas." The *Daily News* is responsible for "a beautiful electric-lighted clock." We come next upon the uncouth word "Electricology," which is the title of a work on electricity, written in 1746 by one R. Turner. Bennet, a well-known electrician of the last century is credited with a proposal for "an electrico-meteorological diary." "Electrify" seems to be Franklin's word, and dates from 1747.

The compounds of "electro" number about a hundred, and although we are not disposed to set up as purists we cannot avoid the observation that many of them are nothing better than base coin. This remark, however, must not be understood as attributing blame to the editor for retaining them. This is no "Dictionnaire de l'Académie" which is to serve as a standard of propriety of language, but it includes everything, whether good, bad, or indifferent. Faraday's words are generally referred to their original source, and we should have thought that "electrolysis" was due to him, but Todd's "Cyclopædia of Anatomy" is the earliest authority given. The word is said to have two meanings: (1) chemical decomposition by galvanic action, and (2) the name of a branch of science. This seems to us to be unnecessary. The word "electro-magnet" only goes back to 1831, which is the date of a paper in *Silliman's Journal*. "Electro-magnetic" dates from 1823, and "electro magnetism" from 1828. We have to note some deficiencies here, and Oersted's papers in the *Annals of Philosophy* for October and November, 1820, would have furnished an earlier quotation for "electro-magnetic," whilst Faraday's "Historical Sketch of Electro-magnetism" in the *Annals* for September, 1821, shows that the word is at least seven years older than stated in the Dictionary. It might also have been worth noting that "electro-magnet" meant originally a solenoid, such as the little apparatus known as De la Rive's "floating battery."

As the Dictionary takes account of words only, some confusion occasionally arises by reason of the same word being used to denote different things. For instance, under "Electrometer" we have a reference to Lane's apparatus known by this name described in the *Philosophical Transactions* for 1766, where the contriver suggests that his instrument "may not improperly be called an electrometer." Under the same heading there are other quotations which obviously refer to "electroscopes," as we now call them, such as Bennet's gold-leaf electroscope. One has to bear this change of name in mind to account for the fact that no authority earlier than 1824 has been found for the word "electroscope."

Under "electro-motive" our contemporary the *Engineer* is quoted in support of the use of this word as a substantive, in the sense of a locomotive engine worked by electricity. This is very sad, and should be rigorously put down along with "electrolier," though we have endured "gaselier" for so long that we fear this last abortion cannot be refused admission into our vocabulary.

The striking character of electrical phenomena seems to have taken firm hold on the popular imagination, and we find accordingly that the technical terms of the science have been largely adopted by general writers in a figurative or metaphorical sense. As early as 1752 Lord Chesterfield writes to his son "you will not be so agreeably electrified as you were at Manheim." Coleridge (1793) has these lines:

> The electric flash that from the melting eye,
> Darts the fond question or the soft reply.

The editors do not often "drop into poetry" or they might have given Clerk Maxwell's poetical rendering of Faraday's discovery. It is so good that it will always bear quotation:

> Around the magnet Faraday
> Is sure that Volta's lightnings play;
>   But how to draw them from the wire!
> He takes a lesson from the heart.
> 'Tis when we meet, 'tis when we part,
>   Breaks forth th' electric fire!

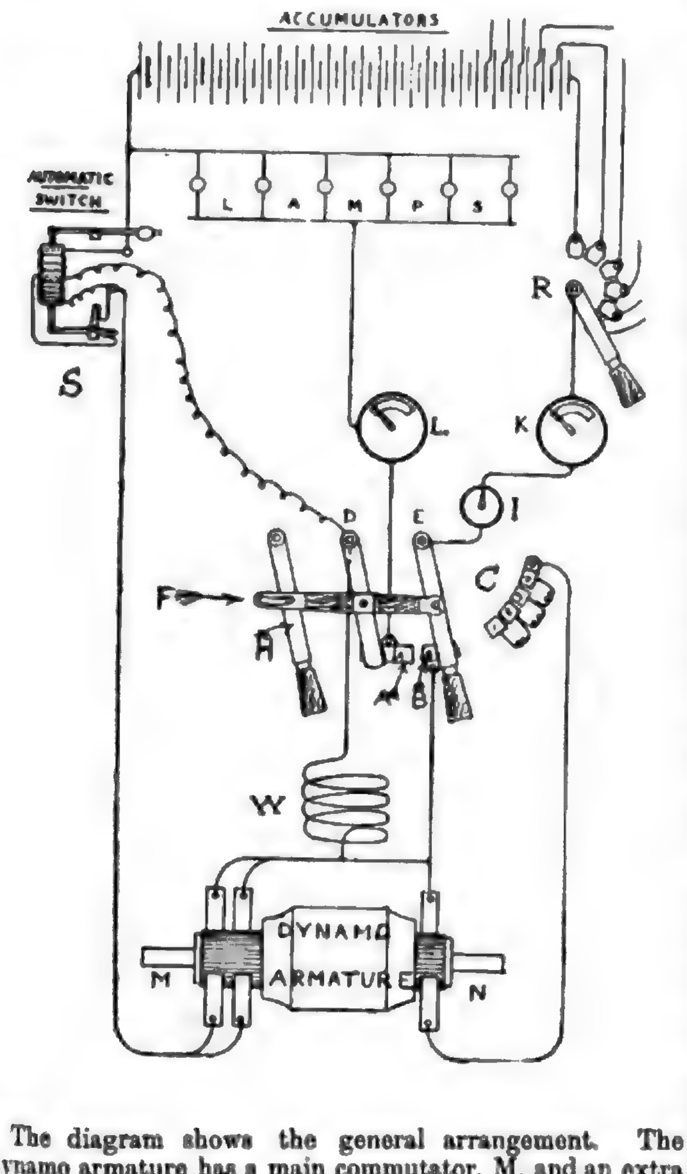
Here is a striking quotation from Carlyle's "Sartor Resartus": "Wait a little till the entire nation is in an electric state; till your whole vital electricity . . . is cut into two isolated portions of Positive and Negative; of Money and Hunger." Max Müller speaks of "the electric light of Comparative Philology."

We have by no means exhausted the interest of this part of the dictionary; and those who are in the habit of occasionally thinking of the words they use daily, as they sometimes scrutinise the image and superscription of a current coin, will find much that is suggestive. As we have already remarked, theories now discarded have left their mark on the language of to-day, and it is more than probable that the words we now invent, and which we think are altogether admirable, will in turn become meaningless.

THE SCOTT-SISLING SYSTEM.

Private installations generally involve the use of accumulators, and to charge these the dynamo voltage must, of course, be raised some 25 per cent. above the lamp voltage. In many cases this is inconvenient and wasteful, as the dynamo must be "run up" to this increased voltage, although only a portion of the current generated may be used for charging, the remainder being required for the lamps at the normal voltage.

We illustrate a neat arrangement devised by Messrs. W. B. Sisling and W. H. Scott, which seems to overcome this difficulty, and has several features which ought to prove advantageous in a private installation. The arrangement may be described as a compound dynamo, with a small supplementary winding on its armature connected to an extra commutator, which gives a voltage usually about one quarter of that given by the main commutator. A branch is taken from the main circuit and connected so that the extra commutator raises its voltage by about 25 per cent. This forms the charging circuit. The dynamo can thus be driven at constant speed, and will supply constant voltage to the lamps from its main circuit undisturbed by the increasing voltage from the cells during charging. The whole of the cells can be charged and a large current supplied to the lamps at the same time, as this does not pass through the regulating cells. The charging can therefore be accomplished during the hours of lighting, instead of the dynamo having to be run specially during the day.



The diagram shows the general arrangement. The dynamo armature has a main commutator, M, and an extra commutator, N. These two commutators are connected in series, either directly or through the dynamo series winding, W. The switchboard contains two switches—viz., the dynamo switch, D, which connects the dynamo to the lamps, and the accumulator switch, E, which connects the accumulators in either of three different ways—viz.: A to the lamps alone, or B to the lamps and dynamo, or C to the charging circuit. These two switches are of the lever pattern, and are interlocked by the thrust-rod, F. The handle, H, acts on the thrust rod so that it can only put the dynamo switch "on." To take it "off" the accumulator switch must be moved so that the accumulators are connected to the lamps alone. When the dynamo switch is put "on" the thrust-rod moves the accumulator switch from A to B, thus connecting the accumulators to the dynamo in such a way that they are in readiness to assist the dynamo in supplying current to the lamps, without risk of weakening or reversing its magnetism. If the dynamo does not need assistance, and spare power is available, the accumulator switch may be moved further from B to C, when the dynamo will begin to charge the cells by means of its extra commutator, N, without interfering with the constant voltage which is supplied to the lamps from its main commutator, M. An index, I, shows whether the accumulators are being charged or discharged, whilst an ammeter, K, indicates the amount of the charging or discharging current. A second ammeter, L, shows the current taken by the lamps. A pilot lamp on the switchboard lights when the dynamo starts up.

By means of this arrangement the manipulation is made simple, and the charging current can be adjusted to form a complementary load, thus working the plant at its maximum efficiency, and shortening the hours of running. The arrangement is in use in some private installations; the latest being one erected for Baron V. de Barreto, of Brandon Park, Suffolk, which is driven by an oil engine giving 11 b.h.p. The engine is started by the accumulators, and these also work the coil, which ignites each charge in the engine cylinder. The whole arrangement seems to work satisfactorily, and without specially skilled attention, which is an important matter for country houses.

DUBLIN CONTRACT SIGNED.

The contract between the Corporation of Dublin and the Electric Engineering Company of Ireland was completed on Saturday. The contract provides for the lighting by electricity of O'Connell-street, Capel-street, Henry-street, Mary street, Parliament-street, Dame-street, College-green, College-street, D'Olier-street, and Westmoreland-street. The premises in Fleet-street are fast approaching completion, and the work of laying the mains under the streets will be commenced immediately. The company will generate electrical energy for 10,000 incandescent lamps for private residences, and for 80 arc lamps for public street lighting. The arc lamps are to be 1,000 c.p. The current will be conveyed in underground wires, enclosed in cast-iron pipes. It is intended to place in each street three sets of pipes, and each pipe will enclose two or more cables. The length of piping ordered for this purposes is six miles, and the length of cable will be about 15 miles. The electrical energy will be transmitted through the wires at a pressure of 2,000 volts. Transformers will reduce the current to the domestic lighting wire to 100 volts. The service-box which draws off the current for each domestic lighting wire will be placed opposite alternate party-walls, so that one service-box will supply two houses.

The public and private lighting systems will be quite distinct as regards machinery and main lines of wire. The apparatus for public lighting will consist of three high-speed engines of the vertical open front type. These engines have been built by the Brush Electrical Engineering Company, Loughborough, will run about 200 revolutions to the minute, and indicate 60 h.p. The public lighting dynamos are also of the Brush type. Instead of belting they will be worked from the engine by endless cotton ropes. The dynamos are three in number, and each will be capable of lighting 55 arc lamps, in all 165, which is more than the number required for the present by the Corporation. For the private lighting Lowrie-Hall alternators are to be used. The engines which will drive these dynamos are also specially built for the purpose by Messrs. Coates and Co., of the Lagan Foundry, Belfast. They are compound machines, capable of working up to 280 h.p., making 80 revolutions per minute, with 153lb. steam pressure in the high-pressure cylinder. The sizes of the cylinders are 17in. and 34in. respectively, and they are both lagged with steel. The steam-pipes are divided into sections, which can be worked independently, so that if an accident happened to one it may be cut off and removed for repairs, and the work go on without it. The engines are fitted with Corliss valves, Messrs. Coates's patent, which admits of very sensitive governing and economical working. The power will be carried from each engine to the dynamos by means of 12 endless cotton ropes.

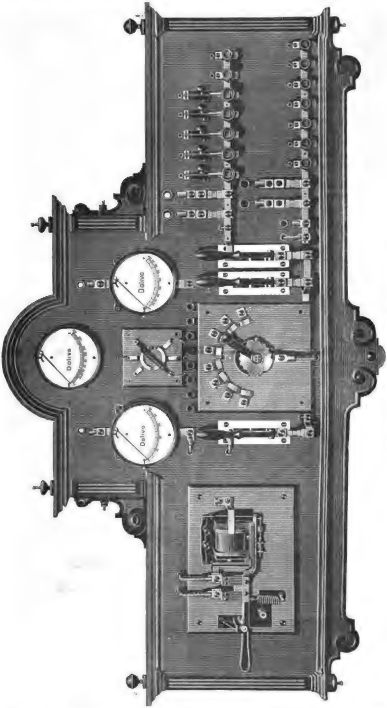
The arc lamps to be used will be of the Brockie-Pell type, single carbon lamps, which will burn 16 hours without trimming. The currents from the dynamos are to be passed through automatic regulators which will keep the current constant, no matter how many lamps are in the circuit.

The charge for domestic lighting will be regulated by meter. The meters, which will be placed in the consumers' houses, will be subject to inspection by the officers of the Board of Trade, who will examine the accuracy of their register.

The contract which the Electric Engineering Company have entered into with the Corporation includes the maintenance of the works in perfect order for a year after the lighting installation has been completed.

MAIN SWITCHBOARDS.

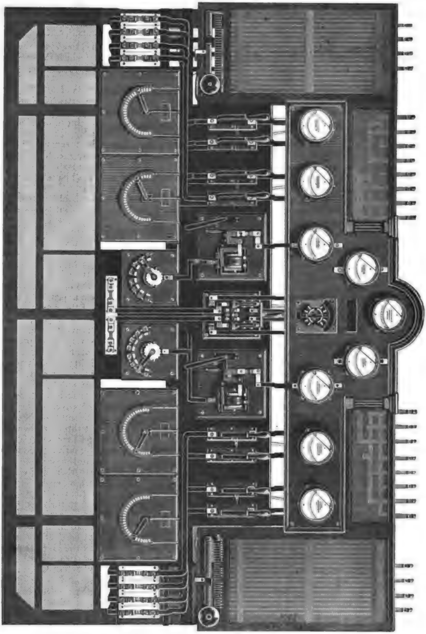
We give illustrations herewith of some fine specimens of main switchboards made by the Allgemeine Electric Company of Berlin, and given in the catalogue recently issued by their London agents, the Keys' Electric Company, of Charing Cross-road.



Main Switchboard for Dynamos and Accumulators.

The first represents a main switchboard for an ordinary house or station installation with dynamos and accumulators, very handsomely and solidly mounted. The arrangements include a Dolivo voltmeter and two Dolivo ammeters, main switches, regulating switch, branch fuses, and automatic charging cut-out.

The second illustration shows with clearness the somewhat complicated arrangements necessary for a large central station plant with high-tension arc lights and a low-tension three-wire distribution, with a battery of accumulators. The switchboard contains eight levers for dynamos. In the centre is the voltmeter with switch to connect to various dynamo circuits. Each side are voltmeters for showing the potential between the leads and the central main. By the side of the voltmeter switch in the centre are two ammeters for measuring the accumulator current. In the centre, under the voltmeter switch, is the switch for charging and discharging the accumulators, and beneath these again are two battery switches for the two batteries for throwing in or out the eight regulating cells. On either side of these are placed, in all, four shunt resistances for the dynamos. In the outer top corners are resistances for regulating the charging current of the accumulators, which, however, are only used when lighting is going on simultaneously with the charging. The various branch mains are taken off the top of the switchboard by means of safety plugs mounted above it upon slate slabs.



Main Switchboard for High-Tension and Three-Wire Distribution, with Accumulators.

THE CONSTRUCTION AND MAINTENANCE OF UNDERGROUND CIRCUITS.

BY S. B. FOWLER.

The numerous disastrous storms of the last winter have brought out very vividly the advantages of having all wires placed underground, and many enquiries have been addressed to the companies operating underground circuits as to their success. It is not probable that all of the answers to these enquiries have been of the most favourable character. To many central station managers an underground system means frequent breakdowns and interruption of service, with, perhaps, slow and expensive repairs, which bring in their turn numerous complaints, loss of customers, and reduced profits. In many installations burn-outs both underground and in the station are frequent, with the natural result that the operating of circuits underground is not there considered an unqualified success. The writer has in mind two very different experiences with underground cables. Several miles of cable were bought by a certain company, carefully laid, and up to to-day not a single burn-out or interruption of service can be attributed to failure of cables; at about the same time another company bought about an equal amount of the same kind of cable, and in a comparatively short time the current had to be shut off the lines, and the whole installation repaired and parts of it replaced. Both of these experiences have been repeated many times, and will be again, although it is simply a distinction between a good cable properly laid and a good cable ruined by careless and incompetent workmanship.

Every failure can be traced to poor work in the original installation, or to the use of a cheap cable, both causes being due generally to that false economy which looks for too quick returns. A poorly-insulated line wire and a poorly-insulated cable are two very different things However, it is a fact that by the use of a good cable it is not difficult to construct an underground system for light, power, telegraph, or telephone uses that will be superior to overhead lines in its service and in cost of maintenance. The ideal underground system must have as a starting point a system of subways admitting of the easy drawing in and out of cables, and affording means of making subsidiary connections readily and with the minimum of expense and interruption of service. This is practically accomplished by a subway consisting of lines of pipe terminating at convenient intervals, say, at street intersections, in manholes, for convenience in jointing and in running out house connections. These pipes, or ducts as they are called, should be for two kinds of service; the lower or deeper laid lines for the main or trunk circuits, and a second series of ducts laid nearer the surface, running into service-boxes placed near together for lines to "house-to-house" connections. In some cities, where it is allowed to run overhead lines, the plan of running but one service connection in a block is followed, all customers in the block being supplied from a line run over the housetops or strung on the rear walls.

This makes unnecessary all subsidiary ducts except a short one from the manhole to the nearest building in the block, and effects a considerable saving in pipe, service-boxes, cables, and labour. The manholes should have their walls built up of brick, the floors should be of concrete, and there should be an inside lid which can be fastened down and the manhole thus made watertight.

For ducts, wood, iron, or cement lined pipe may be used. To preserve the wood it is generally treated with creosote, which, in contact with the lead cover of the cable, sets up a chemical action, resulting in the destruction of the lead. Wood offers but little protection for the cable, as it is too easily damaged and broken through in the frequent street openings made by companies operating lines of pipe in the streets, and as one of the main purposes of a subway is that of a protection to cables, wooden ducts have little to recommend them except their cheapness.

Iron pipes are either laid in trenches filled in with earth, or are laid in cement. Iron pipe will, of course, rust out in time, and if absolute permanence in construction is desired, should be laid in cement, for after the pipe rusts out the duct of cement is still left. However, if we are going to the expense of laying in cement it would be much preferable to use cement-lined pipe, which is not only cheaper than iron pipe, but makes the most perfect cable conduit, as it affords a perfectly smooth surface to draw the cable over and give a good duct edge.

It is not necessary, however, in small installations of cable, especially where additional connections will not be of frequent occurrence, to go to the expense of subways, for cable may be safely laid in the ground in trenches filled in with earth, or can be enclosed in a plain wooden box or a wooden box filled with pitch.

There are, of course, many localities where, if the cable is laid in contact with the earth, a chemical action would take place which might result in the destruction of the cable.

Underground cables are of the following classes: 1. Rubber-insulated cables, insulated with rubber or other homogeneous material. 2. Fibrous cables—so called from the conductors being covered with some fibrous material, as cotton or paper, which is saturated with the insulating material, paraffin, resin oil, or some special compound. Under this latter head is also included the dry core paper cables.

The first thing to do is to get the cable drawn into the ducts, and on the proper accomplishment of this depends to a great extent the success or failure of the whole installation. Probably the ducts have been wired when the subway was constructed, but if not a wire must be run through as a means of pulling in the draw rope. There are several kinds of apparatus for getting a wire through a duct—rods, flexible tapes, mechanical "creepers," etc., but probably the best is the sectional rod. This simply consists of three or four foot lengths of hard wood rods, having metal tips that screw into each other. A rod is placed in a duct at a manhole, one screwed to that, both are pushed forward, another one added and pushed forward, and so on until they extend the entire length of the duct. Then the wire is attached and the rods are pulled out and detached one at a time, and with the last rod the wire is through. At least No. 14 galvanised iron or steel wire should be used, for any smaller size cannot be used a second time, as a rule. In starting to pull in the draw rope a wire brush should be attached to the wire, and to this again the rope, and when the brush arrives at the distant end of the duct it very likely will bring with it a miscellaneous collection of material which for the good of the cable had better be in the manhole than in the duct.

The reel or drum carrying the cable should be mounted on wheels or jacks, and placed on the same side of the manhole as the duct into which the cable is to be drawn, and must always be so placed that the cable will run off the top of the reel.

There are several methods of attaching the draw rope to the cable. As simple and strong a method as any is to punch two or three holes through the cable, lead and all, and attach the rope by means of an iron wire—some of the draw wire will do—run through these holes. Depending on the length and weight of cable to be pulled, it can be drawn either by hand or by a multiplying winch. The rope should run through a block fastened in the manhole in such a position that the rope shall have a good straightaway lead from the mouth of the duct.

The strain on the cable should be perfectly uniform and steady. If the power is applied by a series of jerks, either the lead covering may be pulled apart or some of the conductors broken. At the reel there must always be a large enough number of men to turn it, and keep the cable from rubbing on anything, and in the manhole one or more men to see that the cable feeds into the duct straight and to guide it if necessary. If the ducts are of iron and are not perfectly smooth at the ends, these should be made so with a file, and in addition a protector of some sort should be placed in the mouths of the duct, both above and below the cable. Six inches of lead pipe, split lengthwise and bent over at one end to prevent being drawn into the duct with the cable, makes a very good protector. The cable should be reeled off the drum just fast enough to prevent any of the power used in pulling the cable through the duct being utilised in unreeling it. If this latter is allowed to occur the cable will be bent too short, and the lead covering buckled or broken, and also the cable may be jammed against the upper edge of the duct and perhaps cut through. If the reel is allowed to turn faster than the cable is drawn in the first three or four turns on the reel will slacken up, and the lead covering may either be dented or cut through by scraping on the ground. If the cable end when pulled through up to the block is not long enough to bend around the hole more than half way, the rope should be unfastened from its end, a length of rope with a well-frayed out end should be run through the block, and by fastening to the cable close to the duct, with a series of half hitches as much slack as necessary can be pulled in. If this is properly manipulated there need not be a scratch on the cable, but unless great care is taken the lead may be pressed up into ridges and the core itself damaged. Immediately after the cable is drawn in, if the joint is not to be at once made, the open end or ends should be cut off and the cable soldered up, as most cables are very susceptible to moisture and readily absorb water even from the atmosphere. Where practicable it is always a good plan to pull the cable through as many manholes as possible without cutting the cable; for the joint is, especially in telephone or telegraph cables, the weak point. To do this the rope should be pulled through the proper duct in the next section without unfastening it from the cable; the winch should be moved to the next manhole, and pulling through, then done as before. There should always be a man in every hole through which the cable is running to see that it does not bind anywhere and to keep protectors around the cable. It is not advisable to pull more than one cable into a duct, and never advisable to pull a cable into a duct containing another cable, but if two or more cables have to go into the same duct they should always be drawn in together. Lead-covered cables and those with no lead on the outside should never be pulled into the same duct, for if they bind anywhere the soft cable will suffer where two lead-covered cables would get through all right. Some manufacturers are now putting on their cables a tape or braid covering, which saves the lead many bad bruises and cuts, and is a valuable addition to a cable at very little additional expense.

Practically all electric light and power cables are either single or double conductors, and the jointing of these is comparatively a simple matter, although requiring considerable care. The lead is cut back from each end about 4in. or 5in., and the conductors bared of insulation for 2in. or 3in. The bare conductors should be thoroughly tinned by dipping in the metal-pot or pouring the metal solder over them. A sperm candle is better than resin or acid for any part of the operations where solder is used. A lead sleeve is here slipped back over the cable out of the way, and the ends of the conductors brought together in a copper sleeve, which is then sweated to a firm joint. This part must be as good a piece of work mechanically as electrically. The bare splice is then wrapped tightly with cotton or silk tape to a thickness slightly greater than that of the insulation of the cable, and is thoroughly saturated with the insulating compound until all moisture previously absorbed by the tape is driven off.

The lead sleeve is then brought over the splice and wiped to the cable. The joint is then filled with the insulating compound poured through holes in the top of the sleeve; these holes are then closed and the joint is complete, and there is no reason why, in light and power cables, that joint should not be as perfect as any other part of the cable. When the cable ends are prepared for jointing they should be hung up in such a position that they are in the same plane, both horizontal and vertically, and firmly secured there, so that when the lead sleeve is wiped on the conductor may be in its exact centre; and great care must be taken not to move the cables again until the sleeve is filled and the insulation sufficiently cooled to hold the conductor in position.

It is also very important to see that there are no sharp points on the conductors themselves, on the copper sleeve, on the edges of the lead covering or on the lead sleeve. All these should be made perfectly smooth, for points facilitate disruptive discharges. Branch joints had better be made as T-joints rather than as Y-joints, for they are better electrically and mechanically, although they occupy more room in the manholes. They are of course made in the same way as straight joints, a lead T-sleeve being used, however. For multiple arc circuits copper T-sleeves, and for series circuits copper L-sleeves are used.

Telephone and telegraph cables are made of any required gauge of wire, and with from one to 150 conductors in a cable. In jointing these the splices are never soldered, the conductors being joined either with a twist joint or with the so-called Western Union splice. Each splice is covered with a cotton or silk sleeve, or a wrapping of tape, the latter being preferable, although considerably increasing the time necessary for making the joint. Great care must be taken that no ends of wire are left sticking up, for they will surely work their way through the tape and grounds, and crosses will be the result. The wires should always be joined layer to layer and each splice very tightly taped in order to get as much insulated compound around each splice as possible in the limited space. The splices should be "broken" as much as possible, so as to avoid having adjoining splices coming over each other. After the joint has been saturated with insulating compound the wires should have an outside wrapping of tape to keep them in shape, and then the sleeve is wiped on and filled. If the insulation resistance of the jointed telegraph or telephone cable is a quarter of what the cable tested in the factory, it may be considered that an exceptionally good piece of work has been done. I have spoken more particularly of fibrous lead-covered cables, as the handling of them includes practically every step of the work on any other kind of underground cable. In insulating dry core paper cables a paper sleeve is slipped over the splice, and in rubber cables the splice is wrapped with rubber tape; all other details are the same for these as for the fibrous cable.

In the laying of light and power cables every joint, as made, should be tested for insulation with a Thomson galvanometer, as the insulation must necessarily be very high, and if one joint or section of cable is any weaker than another it may be very important in the future to know it. All tests must be made after the joint has cooled, for while hot its insulation resistance will be very low.

Tests for copper resistance should also be made to determine if the splices are electrically perfect; an imperfect splice may cause considerable trouble. In telegraph and telephone cables the conductors should be of very soft copper, for in stripping the conductor of insulation it is very easy to nick the wire, and if of hard drawn copper open wires will be the result.

All work should be frequently tested for continuity with telephones, magnetos, or small portable galvanometers. It is only necessary to ground the conductors at one end and try each wire at the other end. For this sort of work a telephone receiver used with one cell of some dry battery is most convenient, and has the additional advantage of affording a means of communication while testing, and is by far the best thing for identifying and tagging conductors.

These cables should be frequently tested during the progress of the work for grounds and crosses with a Thomson instrument, and when the cable is complete a careful series of tests of the capacity, insulation resistance, and copper resistance of each wire should be made and the exact condition of the cable determined before it is put in service, and thereafter an intelligent oversight of the condition of the circuits can thus be more readily maintained.

Where a company has extensive underground service, a regular cable gang should be in its employ, for quick and safe handling of cables demands the employment of men accustomed to the work. If the cable has been properly laid, and tests show it to be in good condition before current is turned on, almost the only trouble to be anticipated will be due to mechanical injury. Disruptive discharge, puncturing the lead, may occur; but the small chance of its occurring can be greatly lessened by the use of some kind of "cable protector," which will provide for the spark an artificial path of less resistance than the dielectric of the condenser, which the cable, in fact, becomes.

If a fault suddenly develops on a circuit, the chances are it will be found in a manhole, and an inspection of the cable in the manhole will generally reveal the trouble without resorting to locating with a Wheatstone bridge. The cable is often cut through at the edge of the duct, or damaged by something falling on it, or by someone "walking all over it." To guard against these, the ducts should always be fitted with protectors both above and below the cable. The cables should never be left across the manholes, for they then answer the purpose of a ladder, but should be bent around the walls of the hole and securely fastened with lead straps, that they may not be moved and the lead gradually worn through.

In telegraph cables, when one or two conductors "go," it will probably be useless to look for trouble except with instruments; but if several wires are "lost" at once it will probably be found to be caused by mechanical injury, which can be located by inspection. If it is ever necessary to loop out conductors, a joint can be readily opened and the conductors wanted picked out and connected into the branch cable and the joint again closed without disturbing the working wires. In doing this a split sleeve must be used, and the only additional precaution to be taken is in filling the sleeve to have the insulating compound not hot enough to melt the solder and open up the split in the sleeve. In cutting in service on light and power cables it is entirely practicable to do so without interruption of service on multiple-arc circuits, even those of very high voltage; but they require great precaution and involve considerable risk to the jointer, and where possible the circuit to which the connection is to be made should previously be cut dead. Where the voltage is not dangerous to human life, almost any service connection can be made without interruption of service.

I have only indicated a very few of the operations that may be found necessary, and the probable causes of troubles that may be encountered in the operating of underground circuits, believing that the different problems that arise can with a little experience be successfully met by anyone who has a fair knowledge of the original construction of cable lines.—*Electrical World* (N.Y.).

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TELEPHONY IN LONDON.

The excellent and suggestive paper of Mr. Bennett at the British Association has given rise to a general discussion on telephony and also to a special discussion on telephony, as it is proposed to deal with it in London. The Duke of Marlborough, Mr. Campbell-Swinton, and others have entered with some warmth into this discussion, advocating competition with the company already in the field. So far as we are concerned, we shall assist such competition by every means in our power. Having stated this determination, it may be perhaps thought by readers that some reason for it should be given. It is but just to give some reason, for we are neither in the position of a cricket umpire nor a judge, both of whom have been advised to give decisions but no reasons. From the users' point of view telephony in London is far too expensive, the service is bad, and the cross-talk makes it possible to hear that which you wish not to hear, and to hear doubtfully and painfully that which you desire to hear. As Prof. Kennedy put it in the *Times* of Wednesday, "That the existing telephone service in London is hopelessly unsatisfactory, is but too well known to all of us who have to use it, or—as is much more commonly my own case—to try to use it." For years the management of the present telephonic system was purely financial, and though a gigantic effort has been made since the change of management to cope with the legacy of difficulties, Hercules himself could not satisfactorily perform the task. This much from the users' point of view. If we ask what the existing telephone monopoly has done towards progress, one looks in vain through the files of all the technical papers issued during its existence and finds—nothing. Edinburgh, Newcastle, Manchester, Bristol, and Brighton have contributed to extend our knowledge of the subject both theoretically and practically, but London, both in its applications and its manufacture, has been like an empty safe with the door shut and the key lost. Sounded from the outside it seems filled with emptiness, though when merely looked at it makes an imposing spectacle. The sooner the end comes to such monopoly the better. The best instruments come from Antwerp and Berlin. The switchboards are almost entirely of American origin. Some of the correspondents have been quarrelling over the huge capital of the National Company, and insisting that with proper financial administration and less watering, the rental might well be halved and as good a dividend paid. The people who argue in this strain forget that it pays financialists and promoters better to look after their own interests while they have the chance, than to look after the interests of *bonâ fide* investors through a longer period. Promotions, amalgamations, concessions, family companies and compacts, reorganisations, every move means plums to the skilful wire puller—and who shall say him nay? Not those who benefit with him, not those who buy and sell shares at a profit, not those who get satisfactory dividends: only those who see the way to do a little business themselves. Depend upon it, pure philanthropy plays no part in business projects, and the fewer stones thrown at one set of promoters to curry favour with another set the better. So far as the project enunciated by the Duke of Marlborough is concerned, no doubt it is a purely business project, initiated because money can be made thereby, for which those who promote it have to thank the existing company. The public wants a better and a cheaper service, and, if this can be given, will support those who give it. The system proposed by the Duke of Marlborough and his coadjutors is undoubtedly the best system at present known, and the best system so far as scientific knowledge can foresee. No earth, most wires underground, proper instruments, organisation, and a good service at a low rate ought to bring the telephone into almost or quite every house. From the point of view that assumes the majority of houses fitted, a £10 rental would be a maximum charge; and if users could be brought to co-operate, say, by renting at £9 to every shareholder subscribing to the capital of the company to the extent of £5, while the rental was £10 to every householder not a shareholder, a goodly number of £5 shares would be taken, as the shareholder would get a direct 20 per cent. incentive besides his other advantages; or if this is too much, give him a 10 per cent. by making his stake in the company £10 instead of £5—in other words, appeal to his pocket to support the better scheme.

LOAD FACTOR.

The publication of Mr. Crompton's paper by the Institution of Civil Engineers will call attention once more to the various practical points discussed at the reading of the paper last April. Mr. Crompton is nothing if not practical. Most electrical engineers recollect how he shocked the dry-as-dust bookmen when he took credit of being able to arrive at certain decisions by means of his "eye." It seems to be forgotten that in no one branch is engineering an exact science, hence we make bold to assume that too much attention may be given to the load factor. Mr. Crompton, in his paper, assumes that because we have obtained a certain number of load diagrams we are able to foretell the load factor of any similar district, and implies that a somewhat implicit trust must be put upon the load diagrams now obtained. We incline to the opinion that almost all load diagrams hitherto obtained are misleading, and in the future load diagrams in the same stations will differ considerably from those of the present. Even if work is restricted almost entirely to the supply of the demand for electric lighting, there will come a considerable eration in the load diagrams. Our reason for this mise may be briefly stated. In the earlier days of central station work—and these are early days—by far the larger proportion of the lamps wired are lamps that savour of luxury rather than of necessity. The dining-room and the drawing-room—a few of the best rooms of the house in most cases, in less cases the servants' rooms, the cellars and offices so far as residential districts are concerned—in business houses the shops or salerooms, and not the back, living, or work rooms; in fact, in all those places where show and not use is paramount. From the conditions of the case the demand would fluctuate within wide limits, for almost all these spaces require the light about the same time. If, however, the light is more generally adopted, as it undoubtedly will be, the load diagram will have a different contour, and the load factor obtained from a study of load diagrams in the early days will mislead, and plant designed and arranged to suit this load factor will not be so well designed and arranged as plant designed in view of obtaining a different load factor. Then again a study of load factor will probably bring practical men to select areas for work which are of a mixed character—that is, partly business and partly residential. A station having, say, an equal number of lamps wired in shops and in dwelling-houses, finds the curve of the diagram rising sooner and continuing high longer than one with lamps wired solely in dwelling-houses. The addition of factories and workshops again alters the character of the curve, especially in the morning hours. With such a mixed demand the curve becomes flatter. The maximum demand at one time is but little increased, because the demand in factories and workshops is not made at the same time as that of salerooms and dwelling-houses. It is from such reasoning as this that we suggest the natural course of things will be to give better diagrams rather than to accentuate the peculiarities now existing.

THE NEW SHORT RAILWAY GENERATOR.

It is an event well worthy of notice when one of the large electric railway manufacturing companies puts upon the market an entirely new type of generator. This is particularly true when to general novelty in design are added principles of construction which are so evidently well adapted to their purpose that the advance upon former methods is at once evident even to the uninitiated.

The Short Electric Railway Company has just brought out the first of a series of railway dynamos which are admirable in every respect. They are massive in form, simple in construction, and are marked by the mechanical perfection and finish for which the Short Company is noted.

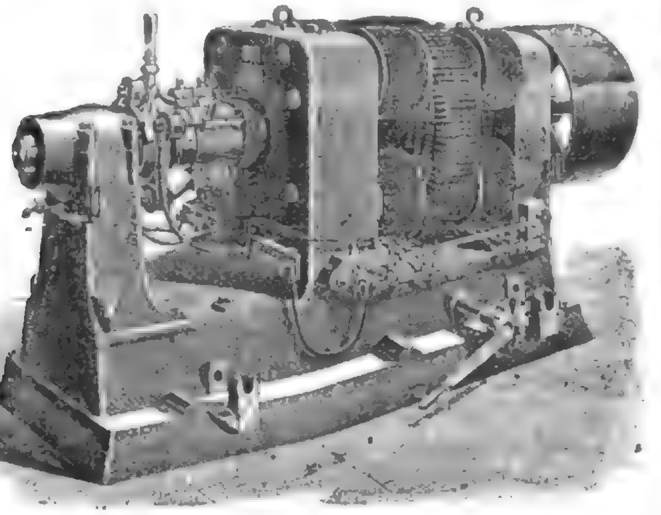
The illustration gives an excellent idea of the 150-h.p. generator, capable of delivering in continuous service 225 amperes at a pressure of 500 volts, equivalent to a total electrical output of 112,500 watts, and having, in fact, a reserve capacity above the normal of at least 30 per cent. in both current and voltage.

The field magnet frame is one of the largest and most perfect single castings ever made for electric work. It weighs over 8,000lb., and nothing but the softest and purest iron is used in the melting-pots. It is annealed very slowly in the moulds, and when finished it is so soft that it can easily be indented with a hammer. For properly finishing up this casting it was necessary to build a monster planing machine, one of the largest to be obtained.

To this heavy frame are bolted light field magnets carrying shunt and series coils, and provided with pole-pieces of peculiar shape, arranged for side presentation to the armature, and so disposed as to make a powerful and almost perfectly uniform "field of force" within a narrow "magnetic gap" of large diameter.

Within this space revolves the armature, which is a distinctive feature of the machine. Its peculiar construction is well known to all who are familiar with the past practice of the Short Company, which was the earliest and for a long while the only prominent advocate of what is known as the "Gramme ring" construction for railway motors and dynamos, and which has come into very general use, the value of which is conceded by street railway managers and manufacturers of electrical appliances generally.

Upon a shaft 9ft. long by 6in. in diameter is keyed a massive spider carrying the foundation ring upon which the armature is built up. The armature core is formed of thin sheet iron wound spirally on the foundation ring and riveted firmly together. The outside circumference of the ring is somewhat wider than the remainder, and this portion is milled out into notches forming a modified Paccinotti ring. The coils are then wound on the core around the hollow ring, the method being such that each one of the 200 coils is entirely exposed to the air on all sides, thus securing the perfect ventilation which is obtainable in no other type of armature. The projecting coils are, in fact, a sort of fan, and in standing before the machine the current of air set in motion by the armature can be detected 10ft. or 15ft. away. As a consequence, both armature and field run cool, and it is almost impossible to burn out a coil even with heavy overloads. Moreover, the destruction of a single coil does not affect adjacent coils, and it is even possible, in case of necessity, to run the machine for several days without rewinding a burned-out coil. A burned-out coil can be rewound by any good mechanic at a cost of two or three dollars and a half-day's labour.



New Short Railway Generator.

One of the most noteworthy features of the armature is its large diameter—viz., 36in.—which, by the way, is also the diameter of the pulley usually employed with high-speed engines.

The details of construction are carefully worked out. The armature shaft runs in large self-centreing and self-oiling bearings, the lubrication being accomplished by rings carried by the shaft and drawing oil from a reservoir in the usual way. The height of the oil is indicated by the little sight-glass on each box. At the commutator-box is also found an adjustable ball bearing thrust collar containing several hundred balls, and so arranged as to carry the armature thrust in either direction without the slightest heating. This is an entirely novel feature in this class of machinery.

The commutator is carefully built and unusually large in diameter—viz., 20in. It has 200 bars, so that the pressure between two adjacent bars is very small and consequently there is no sparking. The brushes are four in number and are carried by two independent collars and sets of brush-holders, in order to secure perfect adjustment at the neutral point. Multiple carbon brushes are used.

The terminals of the field coils are carried to two heavy bars held securely in place on each side of the base of the machine. The plan of connection is simple and in plain sight, and the machines are so exactly duplicates of each other that there is no necessity for complicated "shunt spools" or other adjusting devices beyond the ordinary field rheostat box.

The dynamo is placed on a heavy foundation-plate and moves on V-shaped rails by means of an ordinary ratchet bar and screw.

The electrical properties of the machine are quite as noteworthy as the mechanical. The magnets always work far below the point of saturation, even at heavy overloads. The compounding has been so carefully calculated that the "pressure curve" is a straight line passing from 500 volts at no load to 325 volts at full load, with speed maintained constant at 500 revolutions.

The Short Company is building this type of generator in five sizes—viz., 75 h.p., 100 h.p., 150 h.p., 300 h.p., and 500 h.p. The last-named size will run at about 100 revolutions, and will be connected direct to a vertical compound engine, thus doing away with all belts and shafting. It is probable that even larger sizes will be built later on to accommodate the heavy railway work which is immediately in prospect.

The Short Company is to be congratulated upon this advanced step in street railway work. The entire attention of the company is given to the manufacture of electrical railway apparatus, for which it has exceptional facilities for perfecting every detail, which it is doing with very gratifying results. The Short Company has taken a leading position among the large electrical manufacturers of the country, and a bright and prosperous future is assured.—*Street Railway Journal.*

DUNDEE.

The following is the text of the report by ex-Provost Brownlee and Mr. James Mitchell as to the proposed introduction of electric light into Dundee.

In accordance with the remit contained in minute of the special committee of the Dundee Gas Commissioners anent electric lighting of date July 23 last, we have visited several of the English towns analogous to Dundee, and now beg to report as follows :

BRADFORD.—This installation was opened in September, 1889, and consisted of three vertical engines of 150 i.h.p., working at 120lb. pressure—two of them by Willans and Robinson, and one by Marshall, Sons, and Co.—each coupled direct to a Siemens dynamo, capable of developing 90,000 watts. In October, 1890, the plant was increased by an additional engine of 300 h.p., by Willans and Robinson, driving direct a Siemens dynamo of 240 e.h.p., and at this time the storage cells were installed. The boiler-house, which is situated immediately behind the engine-room, contains three mild steel Lancashire boilers (28ft. by 7ft.), made by Holdsworth and Sons, of Bradford. The Corporation are about to erect another boiler by Babcock and Wilcox. The streets were opened and made good by the Corporation, the cables being laid by the contractors, Messrs. Siemens Bros. Where the cables cross the streets they are placed in brick channels with flag covers, but along the footpaths they are laid in the earth, just inside the kerbstone, with a loose board over them to warn workmen that the cables are below. The cables are of the lead-sheathed class. The dynamos, which are run at a speed of about 300 revolutions per minute, are wound to give a pressure of 150 volts. They are, however, run at 130 volts only, and the loss in the mains being 15 volts, the pressure at the lamp terminals is 115 volts. The average distance from the station to the area of supply is about 1,000 yards, and the largest cable used has a sectional area of 0·8 of a square inch of copper. The present engine-room, which is capable of being lengthened, is about 50ft. long by 22ft. broad, and is fitted with an overhead crane constructed to lift eight tons. On the same floor are situated 65 accumulators by Crompton, Howell, and Co. These accumulators keep up the supply from 10.30 p.m, when the engines are shut down, until about 11 a.m., when one or more of the smaller engines are started. The number of customers presently supplied is 170, and the average number of hours lighted per lamp per day is found to be 1·85. With all the present dynamos running, 3,000 amperes—that is, about 5,000 lamps of 16 c.p.—can be supplied. In the area of supply there are no dwelling-houses or hotels supplied with the electric light, the demand being entirely confined to large warehouses, clubs, offices, and shops. While both the Corporation's engineer and the customers admit that the cost is fully double that of gas, the latter are content to continue its use in respect of its decided advantages over that of gas. The price charged is 6d. per unit. The Corporation are on the eve of extending the station by the addition of one 300-h.p. engine and two 80-h.p. engines, at a cost of from £5,000 to £6,000. The capital presently invested is £35,000, and the revenue £4,000. The sinking fund is calculated to a repayment in 30 years. Up to 31st December, 1889, the loss on the works was £1,097. During the six months ending June, 1890, it was £732, and for the next half-year ending December, 1890, it was reduced to £315, showing that the works are now on the verge of paying their own way. The price of gas in Bradford is 2s. 3d. per 1,000ft. of 16 c.p., and it may be mentioned that the Corporation prefer lighting the streets by gas, using Bray burners, to adopting the electric light. The consumers are charged according to the current used, the same being measured by Aron meters and a rent charged for the use of meters.

DEPTFORD.—This station, which belongs to the London Electrical Supply Corporation, unlike any of the others we visited, generates the alternating current. The generating station is situated at Deptford, and the current transmitted at 10,000 volts to four distributing stations in London. There it is transformed down to 2,500 volts, and it is again further transformed down to 100 volts on entering the consumers' premises. The station measures 210ft. long by 195ft. broad and 100ft. high. The engines driving the two larger dynamos are 1,500 h.p., and are of the vertical marine Corliss type, ropes being used to transmit the power to the dynamos. The engines are compound, and have cylinders 28in. and 56in. diameter by 4ft. stroke. In this station are also two 700-h.p. engines driving two dynamos which give out current at 2,500 volts. This current is, by means of four 150-h.p. transformers, transformed up to 10,000 volts before reaching the mains. These smaller engines are used to keep up the supply during the day, the larger ones being started as the demand for the current increases. This boiler-house contains 24 500-h.p. Babcock and Wilcox boilers, of which only six are at present in use. This company are now extending their plant by putting down one 10,000-h.p. dynamo, driven by two 5,000-h.p. engines. The mains, which are the invention of M. Ferranti, the company's engineer, consist of two copper tubes—one inside, and insulated from the other by brown paper soaked in ozokerite wax, and the whole then protected by an iron cover. They are said to have been working most successfully since 10th February last, notwithstanding the enormous pressure. The charge made by this company is 7½d. per unit. In deciding on a system for Dundee it should be borne in mind that the alternating current cannot be stored, and its use for running motors from it presents several practical difficulties which, we understand, have not yet received satisfactory solution.

CHELSEA ELECTRIC SUPPLY COMPANY, LIMITED.—In this system accumulators play a most important part, they being used to transform the current down from 600 volts to 100 volts. This is done at four sub-stations placed at different positions in the area of supply. The central station is also fitted with accumulators, and a continuous-current transformer, so that the lamps in its vicinity can be lighted either from the dynamos direct through the transformer or from the accumulators, or from both simultaneously. The batteries in the sub-stations are charged in series, and then discharged into the lamps in parallel, the change over being performed automatically. The boilers used at this installation are by Babcock and Wilcox, and at a test about the beginning of this year showed an efficiency of 10·2lb. of water per 1lb. of coal (ash and firing being deducted). This corresponds to 3·64lb. per i.h.p. The engines used by this company are by Willans and Robinson, and are coupled direct to the dynamo. The mains in this case are run in bitumen casing made in 6ft. lengths. The average loss in the charging mains is about 20 per cent., and between the transforming house and the consumers' premises about 2 per cent. 43cwt. of coal are required to produce 840 units, and of this quantity 690 units are sold, or very nearly 7lb. of coal per unit sold. General Webber, in a paper read before the Institute of Electrical Engineers at the beginning of this year, and to which paper we are indebted for a number of these figures, gives the life of the positive plates of the accumulators as three years, and that of the negative plates as six years. This seems to be borne out by experience, for after 18 months' use only 30 single plates, out of a total of 57,970, had to be renewed, and these had been destroyed by accident. In 1888 the makers of the accumulators, the Electric Power Storage Company, undertook to maintain batteries for 12½ per cent. on their cost price, but we are not aware if they still undertake to do so. In Chelsea they reckon that out of every five lamps installed in private houses two represent the maximum number in use at one time, and that 70 8-c.p. lamps is the average number installed in private houses. No house has an installation of less than 20 lamps. There are 1,258 houses, including residences and shops, in the district of Chelsea and Kensington, of which 252 take the current, or actually the equivalent of 20,000 8-c.p. lamps are installed. The maximum number in use at one time is about 8,000. The total length of conductors used in the distribution is 29 miles, and weighs 51½ tons. Aron meters are in use here for measuring the current.

ST. PANCRAS VESTRY.—This installation, which is not yet started, consists of Willans and Robinson's engines coupled direct to the dynamos. There are five Babcock and Wilcox boilers supplying steam to 11 engines. The engine-room, which is provided with an overhead crane, measures 110ft. by 27ft. The switchboard is placed in the engine-room. The mains are of bare copper, and are run on insulators in a brickwork culvert, about 18in. wide by 6in. deep, and covered with concrete slabs. The Vestry, we understand, propose to erect 90 arc lamps for street lighting as well as to supply private consumers. The cost of this installation will be about £85,000, and the price which the Vestry contemplate charging is 6d. per unit. A good demand is expected to arise for the light, the district being one fairly well suited for this object.

CAMBRIDGE has resolved to conclude contracts for carrying out the electric lighting of the town, at a cost not exceeding £26,500, the installation to be 5,000 lights of 16 c.p. This resolution was not arrived at without considerable discussion, several members of Council being very doubtful as to the financial success of the undertaking. The resolution, however, was agreed to, and Prof. Garnett has been appointed electrical engineer to carry out the scheme.

After carefully considering the whole matter we think the Gas Commissioners, if they resolve to supply the light, should adopt the low-pressure continuous-current system, with a station as near the centre of their compulsory area as possible. The engine coupled direct to the dynamo seems also to us to be the best, and a reasonable amount of storage seems advisable. The kind of boilers to be adopted will depend somewhat on the size and shape of the ground the Commissioners may acquire. The Babcock and Wilcox boiler seems most in favour in the South. We observe that it was all Cardiff coal that was being used in them. If adopted, with our coal as fuel, mechanical stokers might be necessary. If at all possible, a larger piece of ground should be secured than hitherto seems to have been considered necessary, as it is desirable to provide not only for expansion, but also for yard room in connection with the station. The design of the building must very largely depend on the shape of the ground, but we think that at one end of the engine and dynamo room, and wrought from the same overhead crane, there should be a small mechanics' shop for the repairs of engines and dynamos, a feature that does not seem to have been provided at any of the stations we have visited. In designing the station the whole ground should be laid out, but only a small portion need be built to begin with, adding to it as occasion may require. Whether the mains should be cased, and what kind of cases should be used, seems to us a question to be determined when the various kinds of casing and their costs are before the Commissioners. We submit plan of ground which, we think, would be very suitable for a station.

Financial Aspect of the Question.

Your committee, while anxious as far as possible to ascertain the relative efficiency of the various systems in operation, cannot overlook what you may naturally consider a very important aspect of the question—viz., the financial aspect. Looking to the many joint-stock companies which have undertaken the supply of electricity, which in the majority of cases have not been financially profitable, we cannot hold out, at least for some time, any prospect of the undertaking in Dundee being free from loss. Yet in view of the great progress which has been made within the last few years, not only in reduced cost of production, but in many improvements for economical distribution, your committee are hopeful that in a short time an installation in Dundee, if wisely gone about, might become at least self-supporting. The many advantages of the new light over that of gas could not fail to recommend it for public buildings, and to shopkeepers and others, in whose premises a bright and cool light is very desirable. The purity of the atmosphere, the preservation of goods, and the general absence of all that tends to smoky ceilings and destruction to pictures and ornamental fittings should in some measure weigh against its cost. It is generally admitted that 6d. per unit is equal to about 4s. 6d. per 1,000ft. of 18-candle gas. On this point, however, it was difficult to obtain reliable information, but that the cost to the consumer would be considerably over that of gas may be reasonably counted on. At present it may be considered a luxurious light, but we must not forget that the luxury of to-day often becomes the necessity of to-morrow, and that the long period of 42 years, during which any company, if once established here, would hold the sole right to supply electricity, is a very important factor in the serious consideration of the question, and should obtain considerable weight in maturing a decision.

At a special meeting of the Dundee Gas Commission on Monday, the committee's report was considered. Ex-Provost Brownlee moved the adoption of the report, stating that though they need not expect the installation to pay for the first few years, experience went to show that it would do so in the future. It would be well to start with a small installation on a site of about 40 rods, with engines of 80 h.p. to 200 h.p., the cost being about £15,000 to £20,000. The station could be extended as the demand arose. The motion was seconded by ex-Provost Ballingall, and Lord Provost Mathewson also spoke in favour. The motion was carried unanimously.

LIVERPOOL.

With the spread of electric lighting and the electrical transmission of power, and especially when under the supervision of a local authority, it will become necessary to institute testing stations, just the same as with gas. Official testing will become common, and no doubt there will be numerous openings for young electricians who can undertake the responsible duties of carrying out *exact* tests. Liverpool has already set a good example, and has furnished a public testing office. The following is the draft scale of charges it is proposed to exact for the work done, and probably this scale will be largely followed by other authorities:

LIVERPOOL ELECTRIC LIGHTING ORDER, 1889.

Draft.

SCALE OF CHARGES.

The Mayor, aldermen, and citizens of the city of Liverpool (being the local authority under the Liverpool Electric Lighting Order, 1889), in Council assembled on the —— day of ——, do hereby, under the powers of the said order, prescribe the following as the scale of fees for testing to be paid by the undertakers to the electric inspector under the above-mentioned order—viz.:

Mark.	Tests to be taken.	Fees. £	s.	d.
I_M	Insulation resistance (in ohms) of main, each test	0	5	0
C_U^M	Conductivity (in mhos) of main ,,	0	7	0
I^S	Insulation resistance of service line ,,	0	2	6
C_U^S	Conductivity (in mhos) of service line ,,	0	4	0
J^S	Insulation resistance and copper resistance of joint	0	3	6
E^T	Tests of energy at testing stations, per diem	0	2	0
E^G	Tests of energy at generating stations, per diem	0	1	6
M	Tests of instruments owned by undertakers, per instrument	0	1	0
L	Earth leakage tests under pressure, per station per diem	0	1	0

EASTBOURNE.

The borough surveyor, Mr. C. Tomes, has made a careful report as to the cost of lighting by gas, oil, and electricity. It will be seen that the cost of electricity is prohibitive. It really seems upon the face of it, knowing the charges for 2,000 c.p. nominal elsewhere (say these are only half that candle-power actually), that £32 a year for 100 c.p. is too much. Even if a 100 c.p. is a mistake for 1,000 c.p., the charge is more than is paid in other places. The following is the text of the report:

Gentlemen,—In accordance with your instructions, I have carefully gone into the matter of comparing the cost of lighting by gas, oil, and electricity, and I beg to lay before you the following.

GAS.

There are at the present time 979 public lamps, but allowing for the increase I find that the average number of lamps lighted for the year ending March 25th, 1891, was 954, of which 58 are 100-c.p. Sugg lamps, and 896 are the ordinary small lamps, averaging about 16 c.p. The 58 large and 828 of the small lamps are lighted for 3,560 hours in the year, and the remaining 68 small lamps are only lighted for 1,714 hours, as they are lighted at 11.30 when the electric light on the Parade is put out. The average consumption of gas for the two classes of lamps is as follows:

100-c.p. Sugg lamps.	Small lamps.
17·16 cube feet per hour.	4·7 cube feet per hour.
61,100 ,, ,, annum.	16,700 ,, ,, annum.

The average cost for gas, labour, and materials for the three classes of lamps is as follows:

	100-c.p. Suggs (all night). £	s.	d.		Small lamps (all night). £	s.	d.		Small lamps (half night). £	s.	d.
Gas	9	13	6	...	2	12	10¾	...	1	6	7
Labour	0	14	4¼	...	0	14	4¼	...	0	14	4¼
Material	0	19	4	...	0	6	4½	...	0	6	4½
Total	£11	7	2¼		£3	13	7½		£2	7	3¾

OIL.

To alter the present lanterns, remove the gas fittings, and provide oil lamps, I estimate the cost would be as follows:

	£	s.	d.
900 14-c.p. lamps, at 8s.	360	0	0
60 100-c.p. lamps, at 20s.	60	0	0
Altering lanterns, etc.	150	0	0
Ladders, lamps, trucks, oil cans, etc.	80	0	0
Total	£650	0	0

Interest and repayment on this amount at 3½ per cent. for, say 10 years, would be £78. 3s. 1½d.; and I estimate the annual working expenses would be as follows:

	£	s.	d.
76,900 gallons of oil at 7d.	2,247	18	4
Wages—19 men and one foreman	1,104	16	0
Lamps, chimneys, repairs to lamps and lanterns, painting, etc.	237	0	0
Depreciation on plant at 5 per cent.	32	10	0
Interest and repayment	78	3	1
Total	£3,760	7	5

The average cost per lamp per annum for the three classes o lamps would be as follows:

	100-c.p. lamps (all night). £	s.	d.		14-c.p. lamps (all night). £	s.	d.		14-c.p. lamps (half night). £	s.	d.
Oil	5	8	0	...	1	17	4	...	0	18	8
Labour and materials	1	1	2	...	1	1	2	..	1	1	2
	£6	9	2		£2	18	6		£1	19	10

ELECTRIC LIGHT.

I have been in communication with the Electric Light Company with reference to this matter, and they do not recommend incandescent lamps for street lighting, as the cost would be quite prohibitive. The Electric Company are willing to supply and light arc lamps of 100 c.p. for £32 per lamp per annum. I have taken as a basis 32 lamps in the streets in which the company's mains are now laid, and I find that those 32 lamps would displace 16 Sugg lamps and 80 small; the comparative cost would therefore be:

	£	s.	d.	£	s.	d.
32 arc lamps, at £32				1,024	0	0
16 Suggs lamps	197	15	0			
80 small lamps.....	294	10	0			
				492	5	0

ON THE MAGNETIC FIELD IN THE NEIGHBOURHOOD OF THE SOUTH LONDON ELECTRICAL RAILWAY.*

BY PROFS. W. E. AYRTON, F.R.S., AND A. W. RUCKER, F.R.S.

In the spring of the present year we were both interested in the question as to how far the work of a physical laboratory would be affected by the neighbourhood of an electric railway.

The South London Electrical Railway runs from Stockwell to the City. It is constructed under the public roads at a depth of 60ft. or 70ft. below the surface. The up and down lines are carried in separate tunnels and enclosed in large iron tubes. The current is conveyed to the trains by an insulated rail, and the circuit is completed through the rails on which the trains run, which are, therefore, in connection with the iron tubes and thus end the earth. Our observations were made at a house, No. 122, in Park-road, under which the railway runs, in two rooms at points distant about 60ft. and 200ft. from the middle of the road respectively.

The instruments used were (1) a rough magnetometer, consisting of needles attached to a mirror suspended by a silk thread about 3in. long, and (2) an ordinary Elliott's square pattern mirror galvanometer, which was used as a magnetometer.

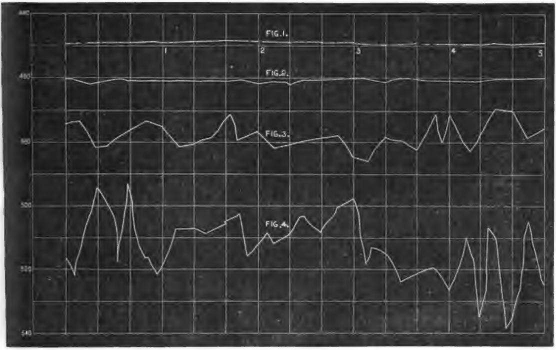
All observations were made when the period of vibration of the instrument used was about 10 seconds. To compare the magnetic disturbances with those due to mere mechanical vibrations, the magnets were removed from another similar galvanometer and replaced by copper rods of about the same mass. The mirror was then suspended by a bifilar, which gave a period of about 10 seconds. This was only intended to detect the effects of shaking on the galvanometer, and it may be sufficient to say that it proved conclusively that at Kennington Park-road the tremors due to the traffic might be almost neglected as source of disturbance when compared with the magnetic effects of the railway.

The latter were continuous, very great, and on one occasion when the line was blocked the instruments were at rest. The oscillations began again at or within a few seconds of the time when a train which had been detained in the neighbouring station had left it This coincidence was most satisfactorily established as some of our party were noting the times of the arrival and departure of the trains, while others were also noting the instants at which the largest disturbances of the instruments occurred.

The passage of a train caused a very sudden disturbance of the needle, especially in the room nearest the line; but the amplitude of these vibrations, though greater, was often not much greater than that of those which were continually occurring at other times. At the stations 60ft. from the middle of the road, the larger deflections produced on a scale one metre distant from the instruments, were about ± 20 mm. At the more distant stations, about 200ft. from the road, they were about two and a half times less. As the instruments were about 10ft. above the roadway, and probably about 70ft. above the line, the distances from the line at the two stations were about $\sqrt{60^2 + 70^2}$ and $\sqrt{200^2 + 70^2}$, or 92ft. and 212ft. respectively. The ratio of these numbers is 2·3, and as the ratio of the disturbances at the two stations was about 2·5, it is evident that they diminish very slowly as the distance increases. The law of the inverse distance was apparently approximately fulfilled. To show the effects of the railway, we publish the comparative diagrams in Figs. 1 to 4.

Readings were taken every 10 seconds of an Elliott's galvanometer, arranged as above described, in: 1. A laboratory of the Royal College of Science, about 150ft. west of the middle of Exhibition-road. 2. Another laboratory about 70ft. east of the same road. 3. A room at Kennington Park-road, about 200ft. from the middle of the road. 4. Ditto, 60ft. from the middle of the road.

Figs. 1 to 4 show the results at each place, 3 cm. corresponding to a minute, and the ordinates being the actual deflections observed.



FIGS. 1, 2, 3, 4.—Abscissæ 3 cm. = 1 mm. Ordinates Deflection on Natural Scale.

The inequalities in Fig. 2 were no doubt due to a dynamo which was working at some distance. Figs. 3 and 4 show the effects of the railway, and prove conclusively that ordinary students' work would be impossible in its neighbourhood.

To emphasise the fact that the standard of sensitiveness adopted was very moderate, we may mention that one of the instruments, arranged as for the experiments, was compared with a small magnetometer constructed by Prof. Boys, F.R.S. The latter instrument was found to be 160 times more sensitive than that employed in the observations just described.

BRIGHTON CENTRAL STATION.

On Monday evening last the central station which has been erected in North-road, Brighton, by the Corporation, was opened by the Mayor, Mr. Alderman S. H. Soper, the Mayoress at the same time switching on the current to lamps in the station, and to shops in the vicinity. Many members of the Corporation were present on the occasion, as also were Mr. J. N. Shoolbred, consulting electrical engineer; Mr. L. Nebel, superintendent of the station; Mr. F. J. Tillstone, town clerk; Mr. F. J. C. May, borough surveyor; and Mr. Baker, water engineer.

Before the current was turned on, the **Mayor** gave a sketch of the progress of electric lighting in Brighton, and the reasons which led the Corporation to establish a station of their own. With regard to what Brighton had done in the matter of the electric light, he said that some eleven or twelve years since, the Corporation commenced making enquiries about the light of the future, and since that time the electric light had made rapid strides. For some time they had watched the progress of lighting by electricity with a view to adopting it for public use as soon as it could be shown that it could be done with advantage, and that there was a demand for it. With this view they consulted from time to time with eminent engineers, among them the late Dr. Siemens, Mr. Alexander Siemens, Mr. Preece, Mr. Gooch, and other electrical engineers of known reputation. In 1879 and 1880 extensive experiments were carried out at Goldstone Bottom Water Works by Mr. Easton and the Hon. Reginald Brougham. In February and March, 1881, the Marine-parade was brilliantly lighted by Messrs. Siemens Bros. as an experiment, and several estimates were prepared by Messrs. Siemens for lighting the whole of the front of the town, but they were found to be too expensive. That was the year in which Mr. Alderman Hallett was Mayor of Brighton, and he only regretted he was not there then, for if there was one man in the Town Council who understood electric lighting better than another it was Mr. Alderman Hallett. In 1881 and 1882 the Health Congress and Sanitary Exhibition were held at Brighton in the Pavilion, Dome, and Corn Exchange, and the buildings and grounds were lighted by the British Electric Light Company and by the Brush Electric Light Company. That was a great novelty to Brighton, and it was very much admired, but the time had not then come when they could adopt it for their own purposes. In 1883 the Corporation applied for and obtained a provisional order, giving them power to supply electricity under the Electric Lighting Act of 1882, and it was proposed to acquire premises and to erect an electric lighting station in West-street, but the Council did not think there was a sufficient demand for the light, or that its success was sufficiently assured to justify the outlay, and the matter was consequently allowed to remain in abeyance for a time, as far as related to the general supply. But the Town Council still persevered with their experiments, and in 1883 they lighted the Royal Pavilion with an installation of 500 incandescent lamps. In 1884 the lighting was extended to the Dome Assembly Room, the Library and Museum, with the addition of about 400 lamps, making an equipment of about 900 lights. The late Alderman Lamb was then very sanguine on the subject, and he took it up very energetically, and it was he who advocated the site in West-street. But he (the Mayor) thought they would agree the present premises occupied a better position than those which were suggested in West-street. In 1884 the Corporation received a report from Mr. W. M. D. Gooch as to the lighting of the sea front by electricity, and the Committee of the Town Council had extended their enquiries, and had at different times visited the establishments of the Edison Electric Light Company, Messrs. Davey, Paxman, and Co., the installation at Colchester, and other systems in London and at Eastbourne. So during these years the Town Council were not standing still. On the contrary, they were looking about them to find out the best installations and get the greatest information they possibly could before venturing upon an installation of their own. They were very careful not to embark in the undertaking until the success of the light was reasonably assured, and the matter was not taken up again with the view of setting up an installation for the supply of the town generally with electricity till the summer of 1889. The Council then instructed Mr. Shoolbred, who was the engineer who had designed those premises and had seen to the carrying out of everything connected with the installation. The large town of Portsmouth had also engaged Mr. Shoolbred to carry out their installation, which would be much larger at first than the one at Brighton. Mr. Shoolbred was instructed to report on the matter in the beginning of 1890, but there were several causes of delay, and the result was that the works were not actually commenced until about 12 months ago. As a matter of fact it was not 12 months ago that these works were commenced, for the first stone was laid by his (the Mayor's) predecessor, Mr. Alderman Manwaring, on the 4th of November last, so no time had been lost in bringing them to a completion. There had been differences of opinion as to which was the better system to adopt for Brighton, whether the alternating or the direct-current system at low pressure. The latter had eventually been decided on, and it had also been adopted by Bradford, Hull, York, Portsmouth, Glasgow, and the St. Pancras Vestry, as well as other places. Some of the important reasons why the Corporation should supply electricity to the inhabitants of Brighton were: First of all, pure light was as necessary to all of them as were pure air and pure water. There could be no doubt that the electric light was far in advance of gas as regards purity. Both on account of non-vitiation of the air they breathed, and because it did not injure decorations in private houses or the stocks in tradesmen's windows, the electric light was preferable to gas. Then with it there was no likelihood of accidents from matches or tapers. Another reason was that, seeing the many advantages to be gained by the electric light, and being sure that it would be the light of the future, numerous companies had been started with the idea of gaining a monopoly of its supply in order to make a profit out of it for which the public would have to pay; and if a profit was to be made, which he was sure would be the case, it was far better that they should make a start than in a few years have to pay any company an enormous sum of money as compensation, in order to get possession of the right to supply the townspeople with it. When corporations supplied gas, water, or electric light, and they were encouraged by the Government, it became their duty to supply it as efficiently and as cheaply as possible. Moreover, whenever a corporation applied to the Government for power to annex water, gas, or electric light for the benefit of the whole community, the Government said: We will do all we can to assist you in obtaining powers to supply what we think you should have the distribution of for the good of the public. It was now too late to take over the gas, and, perhaps, that was as well for them at the present time. But those corporations who did some years ago take it over had found it much to their advantage. Another reason for the Corporation supplying electricity was they did not like others to tear up their roads as they might think fit to do, it being very objectionable. All towns of 100,000 inhabitants, with very few exceptions, had secured the right for their municipal authorities to have the control of the supply of electricity in their own hands. Portsmouth was just about to start with an installation which Mr. Shoolbred would have the honour of carrying out, to cost about £60,000. and Manchester with one of about £150,000, whilst Bradford was about to triple its installation. The Corporation of Bradford charge 6d. per unit, so that Brighton which began with charging 7d., had a good margin for profit, and no ratepayer need fear having to put his hands in his pocket for the electric light which his neighbour might be using. He might say that seven-eighths of those towns who were supplying electricity had adopted the low-pressure system, supplemented by storage batteries, and he had therefore no doubt that they had adopted the best system they possibly could have done, and that it would prove to be a great success. What they had done up to the present was but an experiment, and they could only supply a portion of the town, but if they might judge from the number of applications they were having for the light, it was only fair to assume that they would soon have to extend their operations. The best thanks of the Council were due to Mr. Moon, the chairman of the Lighting Committee, and to the other members of the committee, everyone of them, for the large amount of time and the great attention they had given to everything connected with the works which were now completed. He must also compliment Mr. Shoolbred, the engineer, upon having so far carried out his duties in such an able manner. They would all agree that the work which they saw there must have had a master mind, and involved an immense amount of labour, both to think out and to see properly carried out, and he could only hope and believe that what had been done would be a guarantee of great success in the future. He would also compliment Messrs. Chappell, the contractors, on the very substantial manner in which they had erected the buildings connected with the works.

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* Paper read before the British Association.

Mr. Shoolbred having briefly and in a popular manner explained the system of distribution adopted, the Mayoress turned a switch and lighted the lamps in the dynamo-room, the **Mayor** exclaiming with respect to the light: "May it always be a bright and shining light, and prove of good service to the community."

Then followed light refreshments, and the usual votes of thanks to those who had taken the chief parts in the ceremony.

Description of Works.

The following is a short description of the works: The buildings, plain, but very substantial, have been erected by Messrs. Chappell, of Lupus-street, Pimlico. The boilers and large steam mains were manufactured by Yates and Thom, Blackburn. Messrs. Sharp and Kent were responsible for the supply of the Willans engines and Goolden dynamos, switchboards, instruments, pumps, and all the steam and water connections, etc. Messrs. Callender and Co. made and laid the cables, and the Electrical Construction Corporation supplied and fixed two sets of accumulators with their corresponding regulating boards. An arched gateway leads from North-road into the boiler space divided by the chimney into two halves—the first is a reserved space for a future three boilers, and used at present as coal, etc., store; the second contains three mild steel Lancashire type double-flue boilers, 7ft. by 28ft., with five conical Galloway tubes in each flue, and made for a maximum working pressure of 150lb. per square inch. Opposite the boilers, in a smaller room, are two steam pumps, each capable of delivering 2,000 gallons per hour, and connected with an Atkinson feed-water heater placed beside the boilers, and connected to the main (12in.) exhaust. Behind and south of the boiler space is the engine-room, about 34ft. square, containing 2-II and 2-GG Willans central valve engines, coupled to two 120 K.W. and two 45 K.W. Goolden's shunt-wound dynamos respectively, the former to give 800 amperes and 150 volts at a speed of 350 revolutions each, and the latter 300 amperes and 150 volts at a speed of 450 revolutions each. There is also one spare armature provided for the large and one for the small dynamo. Each dynamo is connected to a separate + switchboard containing an interlocking main and shunt switch, automatic cut-out, voltmeter, and main and shunt ammeters, the main current from these boards passing through a system of collecting bars to the six regulating boards, each connected through a variable resistance to one of the six + feeding mains. Each regulating board contains a multiple contact switch, a volt and ammeter. The − or return feeders are all collected (through a fuse each) on one bar on the return board, the total current passing through two ammeters in parallel into another bar connected to a row of six switches, one to each − dynamo terminal and one to each − battery terminal. The + ends of the two sets of batteries after passing through a culvert under the gangway separating the battery-room from the engine-room, are connected on to two multiple contact regulating boards with a range of 16 (cells) contacts for charge and discharge, two main switches, a volt and ammeter each; the connections from these boards go on to the collecting bars. The battery-room opposite and east of the engine-room contains two sets of accumulators in two tiers, 68 cells per set. Messrs. Callender have laid about 3,200 yards of ·3 and 5,300 yards of ·4 steel tape-armoured distributing cable, and about 3,850 yards of ·5, 5,600 yards of ·6 and 3,450 yards of ·7 feeders; these latter are laid in cast-iron troughs and filled up solid with bitumen.

DOVER ELECTRIC LIGHTING.

The usual weekly meeting of the Managing Committee of the Dover Town Council, acting as the Urban Sanitary Authority, was held in the Council-chamber on Tuesday, Sept. 8th, when the following letter was read from the Brush Electric Lighting Company :

The Brush Electrical Engineering Company, Limited, Belvedere-road, Lambeth, London, S.E., September 5th, 1891.

E. Wollaston Knocker, Esq., town clerk, Dover.

Dear Sir,—Referring to previous correspondence, we now have pleasure in submitting to you our definite proposals, and in doing so we think it better to confine ourselves, in this letter, to the principles underlying the proposed arrangement, and if we find that we are in accord with your Corporation upon these, we will undertake, before the proposed arrangement is carried into effect, to supply you with all other particulars and details that are referred to in your specification, or that you may require. We suggest that your Corporation should enter into an agreement with this company, of which the following would be the heads :

1. That your Corporation should agree to transfer the Dover Electric Lighting Order, 1890.

2. That your Corporation should enter into an agreement for the public lighting of certain thoroughfares at Dover by arc lights, upon the basis of our tender, marked "A," enclosed herewith.

3. That your Corporation shall have the power to acquire the electric lighting undertaking at the end of 21 years, and at subsequent intervals of 10 years, upon paying for the undertaking as a going concern, including valuation and the goodwill.

4. That if and when in any year the balance of receipts over expenditure, after allowing for depreciation and for a reserve fund, exceed a cumulative profit of 10 per cent. per annum on the amount of the total capital expended on the undertaking, the price for the supply of electricity to private customers shall be reduced one farthing per Board of Trade unit for each 1 per cent. above such 10 per cent. profit.

5. That your Corporation should undertake, during the period of our holding the Dover Electric Lighting Order, not to give their consent to any other provisional order or license being granted.

6. That we shall, at the time of execution of the contract, at our option, deposit or secure by bond to the satisfaction of the Corporation the sum of £1,000 as a guarantee that we will carry out our obligations.

7. That the agreement shall be subject to the formation of a local company called "The Dover Electric Lighting Company," with a nominal capital of £50,000, and generally with a constitution which shall be satisfactory to your Corporation, and that the proposed agreement shall be transferable to such company.

8. That generally we shall agree to the insertion by the Corporation in the contract of clauses providing for the other points mentioned in your specification, so far as the same are applicable to the arrangement proposed to be entered into.

With regard to the questions contained in your letter of the 22nd July we understood the payment of £500 to be made to the Corporation to be in respect of the cost of obtaining the provisional order, and we would suggest that the payment to be made by the company to be formed should be limited to the actual cost incurred by the Corporation in obtaining the order.

"A."

Tender to the Corporation of Dover for Public Lighting.

As regards that portion of the area included within your provisional order, which is merely permissive and not compulsory, we may say at once that the cost of laying the electric mains for the purposes of public lighting alone, would necessitate so high a charge being made for the light, that we do not propose to submit at the present time any tender for electric lighting in regard thereto. Public lighting throughout this area will become economically possible to your Corporation, as and when the electric mains are laid down for private supply. As regards the compulsory area scheduled in Schedule 2 of your order, we are of opinion, confirmed by a recent survey by our engineer, that in respect of some portion of this area, the Corporation will not feel themselves justified in deciding to largely increase the quantity of light over that now in use, if such increase involves increased expenditure. The advantages and economy of electric lighting, which are but small when lighting by incandescence lamps in the streets without a sensible increase in the total quantity of light, are most felt when an increased quantity of light is required, and when that increase is supplied by means of arc electric lamps. But the greatly increased light thus afforded cannot be supplied at the same price to the ratepayers as the less light at present yielded by gas : although the increase of light would be proportionately much greater than the increase and cost to the ratepayers. We may quote in illustration of this the fact that in the City of London, for the public lighting of the major portion of which the Brush Electrical Engineering Company is under contract with the local authority, existing gas lighting—equal to a total of some 35,000 c.p.—is to be replaced by electric lighting to a total of some half a million c.p., an increase of 15 times its light, at a cost to the ratepayers of only rather over twice as much as is now paid for gas.

In submitting to your Corporation a tender for public lighting at Dover, therefore, we have approached the matter from this point of view—that is to say, we have endeavoured to select that portion of your compulsory area in which we apprehend the Corporation of Dover would desire to provide an increased illumination, and be willing to pay a somewhat increased price therefor.

With this object we have selected the following public streets and ways in which we would propose to install arc lamps of 2,000 nominal candle-power each, placed on an average two chains apart, and mounted on ornamental iron columns 21ft. in height : The Esplanade, Waterloo-crescent, Marine-parade, East Cliff-terrace, Granville-gardens, Market-square, King-street, Bench-street, New Bridge.

We have marked upon accompanying map, No. 1, the proposed position of these lamps, while the enclosed design, No. 2, illustrates the lamp columns which we propose to employ.

Under this proposal we estimate that the public ways named above would be lighted upwards of 12 times more effectively and brilliantly than at present—say, 3,800 c.p. of the existing gas lamps being replaced by 49,000 actual candle-power of electric light at, say, twice the present cost to your Corporation.

Our calculations are based on the assumption that the whole of the lamps will run from sunset to midnight throughout the year (Sundays included), and that one half (every alternate lamp) will continue to burn until sunrise, the other half being extinguished at midnight.

We, therefore, now beg to make the following proposition :

1. That the Corporation of Dover shall enter into a contract for public lighting with the local company to be formed to carry out the provisional order, for a period of 21 years, determinable by either side at seven or 14 years, for lighting the public streets herein named, by means of 47 arc lamps of 2,000 nominal candle-power each, for the sum of £1,245 per annum.

2. The period of 21 years to date from the commencement of the public lighting, as herein specified.

3. In the event of the Corporation desiring to add to the above number of lamps from time to time, the local company shall undertake to supply, erect, and maintain such additional lamps, under the conditions named above in such public streets and ways as their mains for private supply are already laid, upon the following terms : For each arc lamp burning from sunset to sunrise, £30 per annum ; for each lamp burning from sunset to midnight, £23.—Yours faithfully,

A. Broadhurst, Secretary.

Councillor Barnes moved that the letter and tender should be printed and circulated amongst the Council, as it was most important. They seemed nearer electric lighting than hitherto, but he thought they ought to have the terms for bringing the light as far as the Town Hall.

Councillor Brown seconded.

Alderman Fry said that through the letter a local company was mentioned. Where were they ? He thought they ought to treat with the Brush Electrical Light Company and not with a dummy. It seemed to him that the Brush Company could draw out of it when they liked.

Councillor Pepper said he agreed with the alderman to some extent. The whole proposal was subject to the Brush Company being able to form a company, and if they were not successful in that, they could get out of it. But he thought they had better agree to the motion.

Councillor Peake asked that they should have the cost of lighting by gas in the streets which it was proposed to light with electricity brought up at the same time.

This was included in the motion, which was carried.

THE ELECTRICAL CONGRESS AT FRANKFORT.

Frankfort-on-the Maine was at one time noted for being a town which, though picturesque, showed signs of dilapidation. This is, however, now no longer the case, and when the members of the International Electrical Congress met there on the 7th inst., those who had been in the old days found that modern improvements had been initiated.

The congress has proved to be truly international, the principal European countries and America being represented. Out of 800 members of the congress 198 came from abroad. Among those from England there were to be noticed Messrs. W. H. Preece, R. E. Crompton, G. Forbes, G. Kapp, S. Thompson, A. Reckenzaun, A. R. Bennett, etc. Among the Austrian representatives were Messrs. A. von Waltenhofen, Kareis, Déri, and Zipernowski. France was represented by Messrs. Hospitalier and Korda, and Italy by Prof. Ferraris. Of course the German element was very strong, and included Messrs. von Stephan, Heldberg, Grawinkel, Werner von Siemens, F. Uppenborn, and Kohlrausch. The American Institute of Electrical Engineers was represented, among others, by Messrs. Hering, Heinrich, Nichols, and Gutmann, and Belgium by M. Eric Gerard.

The members of the congress were welcomed in the restaurant of the exhibition on Monday by Mr. Hartmann, of Frankfort, on behalf of the Frankfort Electrical Society and of the Reception Committee. He stated that he was very much pleased to find that the number of members had far exceeded expectations. Mr. Sonnemann, on behalf of the management of the exhibition, also expressed his pleasure at meeting the members of the congress, without the holding of which the objects of the exhibition would not have been fulfilled.

Principal Meetings.

The inaugural general meeting took place on Tuesday, at 9.30 a.m., under the honorary presidency of Herr von Stephan, secretary to the Post Office, in the Victoria Theatre of the exhibition. After some preliminary remarks had been made by way of welcome by Mr. Heldberg, honorary president of the Frankfort Electrical Society, **Herr von Stephan** formally opened the congress in lengthy speech. He said that the fact that so many had come from distant countries to participate, showed that the holding of the congress was a necessity of the time. After referring to the first electrical congress in Paris and to the present numerous applications of electricity, Herr von Stephan stated that the demands upon the coal supplies were very considerable, and the question therefore arose whether it was not possible, in transforming fuel into electricity, to obtain a higher efficiency from the plant, and also at the same time to diminish the consumption of coal. This important point should receive serious attention, as it would probably be a very long time before the direct heat of the sun could be utilised in place of the stored-up heat of the sun, or before "another power could be employed as a source of energy." The speaker did not believe in speculation in electrical undertakings, but he was of opinion that competition brought forth good results. Although much good work was done in the study, the laboratory, and the workshop, the true value of congresses lay in the exchange of ideas by public discussion. In conclusion, Herr von Stephan urged his audience not to weary in working, and he then declared the congress open.

A few remarks were then made by **Prof. Ruhlmann**, of Hanover, the Nestor of the assembly; by **Mr. Adickes** in the name of the town of Frankfort, and by **Mr. L. Sonnemann** for the exhibition committee.

On the motion of **Mr. Hartmann**, Dr. Werner von Siemens was elected as president, and as he expressed his desire to have assistance, Messrs. Preece, Hospitalier, Ferraris, von Waltenhofen, and Kohlrausch were elected as vice-presidents Messrs. Uppenborn, Heim, Ebert, and Hartmann were appointed secretaries of the meeting, whilst Messrs. Epstein, May, von Nordheim, and Lepsius were elected secretaries of the sections. A special section was arranged to deal with electrical legislation.

After luncheon, **Prof. Kohlrausch**, of Hanover, raise a discussion on "What is the most suitable course of instruction for electricians?" He was of opinion that a thorough electrical engineer should have a considerable knowledge of mathematics and drawing, but the subject of the greatest importance was physics, and especially in relation to electricity and magnetism; a knowledge of chemistry would also prove useful, but machine construction was of secondary importance. **Prof. Slaby**, of Berlin, differed from the speaker on the last point, and strongly advocated theoretical and practical instruction in machine-building, as laboratory work alone was, in his opinion, only a form of recreation. This opinion was shared by several. **Dr. Werner von Siemens** advocated that a man should first become a mechanical engineer and subsequently go in for deep theories, if he desired to do so. That was the way in which the electricians of the past had been made.

Prof. Silvanus Thompson followed, in German, with a paper on "The New Sphere of Alternating Currents." He traced the history of the subject from the time of the inventions of Faraday, in 1831, onwards; but he mentioned that little was generally known on the subject for a long time, and as recently as 1882 the Patent Office at Washington hesitated to grant a patent for a transformer, in the belief that it was unworkable. Since then, however, alternating-current dynamos had made great progress, together with transformers. It was remarkable that the theory of the electrical transmission of energy which had been established by Deprez and Carpenter, in 1881, was not practically utilised for so long a period. The year of the present exhibition was noteworthy for the demonstration of what could be done in that direction, as exemplified in the Lauffen-Frankfort transmission plant. The whole subject of alternating currents was now being busily studied, and a new field had been opened to electricians. There was no doubt that in a few years pictures would be electrically transmitted, as was already the case with the voice. The electrolytic applications of the alternating current had so far been scarcely looked into, and there remained also for invention octuple telegraphy, telegraphy and telephony without wire, and oceanic telephony, among other subjects. The future of electric science lay in the cultivation of the wave theory of electricity.

In the evening a dinner was given in the hall of the Palm Gardens, at which Dr. Werner von Siemens occupied the chair.

Wednesday, Sept. 9, was devoted entirely to sectional meetings, and on the 10th the second general meeting was opened in the morning, when Dr. von Siemens again presided. The question of the adoption of the name "henry" for the unit of induction was remitted to the first section for consideration.

Mr. Lowenherz, head of the Government Physical-Technical Institute at Charlottenburg, read a paper on "The Introduction of a Standard Screw Gauge in the Electrical and Allied Industries." Although in heavy engineering the Whitworth standard had been generally adopted, and in America the Sellers standard was similarly employed, there was until lately no normal thread for small screws. The attempts made in various places to remedy this were based almost entirely upon the metric system. He dealt with the history of this subject, and referred to the recent proposals made in Germany, and agitated for a thorough test of the same. A proper result could only be obtained by the universal acceptance of the metric system.

Mr. Hospitalier followed on "Notations and Symbols of Electricity," in which he advocated that there should be universally valid signs, formulæ, and nomenclature in electrical science as already existed in mathematics. New names should be accepted with great caution, but a universal name for such new developments as "rotary current" was very desirable. **Dr. von Siemens** stated that the question would be dealt with by a committee to be appointed. **Mr. Uppenborn** desired a unification of the unit of work, horse-power meaning a different thing in different countries. **Prof. Kohlrausch** said that the kilowatt would soon be adopted as the unit of work, a view which was approved by subsequent speakers.

Dr. Oscar May next read a paper on "Precautions respecting Electric Conductors from the Standpoint of Fire Insurance Companies." It was in the interests of electric lighting companies themselves that installations should be so carried out as to ensure safety. Rules had been laid down by various insurance companies, but these differed from each other, and rules which should be general were desirable. They should not go much into detail, but should lay down broad principles for the carrying out of installations. A brief discussion followed, in which **Messrs. Uppenborn, Geist**, and **von Waltenhofen** took part.

The general meeting then divided itself among the sectional gatherings.

At the third general meeting, held on the 12th inst., reports were received from sectional committees. With regard to the question of symbols, it was recommended that italic letters should be used as signs of dimensions, roman letters as signs of units, and Greek letters for physical constants and angles; that the units "joule" and "watt" should be universally adopted; and that the units ampere, coulomb, farad, joule, ohm, volt; and watt should be represented by their initial letter. No definite decision was, however, come to, and the question is postponed to a future date, as is also that as to the adoption of the "henry."

Mr. Zipernowski then dealt with the subject of "Electric Railways for Rapid Interurban Traffic," in which he described the electric railway projected by Messrs. Ganz and Co. between Vienna and Buda-Pesth, details of which have already been given in the *Electrical Engineer*.

Dr. Epstein advocated the extension of the system of establishing electrical experimental institutions.

The **Chairman** (Herr von Waltenhofen) then declared the congress at an end, as far as business was concerned, but excursions were made to Wiesbaden and Lauffen on Monday and Tuesday respectively.

The sectional meetings already referred to were as follow:

First Section.—Theory and Measuring Science.

Dr. von Waltenhofen, of Vienna, presided over this section.

Dr. Koepsel, physicist of Messrs. Siemens and Halske, treated of the present position of measuring science, dividing the subject into direct and indirect methods of measuring current.

The second paper was on normal elements by **Dr. Lindeck**, of Charlottenburg.

On Wednesday this section was first presided over by Prof. F. Kohlrausch, of Strassburg, and later by Prof. Ferraris, of Turin.

Dr. Voller, of Hamburg, read a paper on the "Presentation of a Method for the Demonstration and Investigation of Electric Waves in Conductors." After dealing with Hertz's investigations, the author stated that an improvement had been effected by Mr. Lechler, of Vienna, and that it had been demonstrated recently in Bremen.

Prof. Moller, of Brunswick, next dealt with static and kinetic energy, an axiom of dynamics.

The magnetic conditions of various iron alloys was the subject of a paper by **Dr. Holborn**, in which he pointed out that steel magnets, in order to remain in good condition for a length of time, required to be tempered. More attention should be paid to the important influence exercised by the heat at which tempering was done. **Dr. Bruger** having dealt with the use of certain measuring instruments for alternating currents, was succeeded by **Dr. Feussner** on the material and construction of measuring instruments.

Dr. Quincke, of Heidelberg, referred to a new form of electro-magnetic measuring instrument constructed by himself. The apparatus combines three in one—namely, a magnetometer, a tangent compass, and a multiplicator. **Dr. H. F. Weber**, of Zurich, treated in a paper of the general theory of the incandescent light, while **Dr. du Bois** dealt with magnetic circuits and their determination.

Second Section.—Strong Currents.

Prof. W. Kohlrausch presided over this section on Tuesday, and Mr. Carl Hering of the *Electrical World* (New York) acted as vice-president.

Mr. Geist, of Cologne, dealt with electrical machines with arrangements for the measuring of mechanical power. **Messrs. F. Uppenborn, Mullendorf, G. Kapp**, and **Prof. Vogel** joined in the discussion.

Dr. Forderreuer, of Nurnberg, next treated of the rotary-current motor. It was pointed out how simply an ordinary voltmeter could indicate when a motor had assumed synchronism with the primary generator.

Mr. M. von Dolivo-Dobrowolsky, of Berlin, read on Wednesday a paper on "Electrical Transmission by Alternating Currents." He said that the course of magnetism and of tension was not simultaneous with alternating currents, and that each alternating current was the result of two currents—the exciting current, and a second which the speaker proposed to call "watt current. The often-raised subject as to whether an alternator had self-induction might only be answered that well-built motors, whether of one or multiphase type, could be made by simple means to work economically. Motors of the unsynchronous type, to which the rotary-current motors belonged, also ran economically if they worked with three or more currents. They required comparatively more iron, but notwithstanding that, they yielded a good efficiency. According to the speaker, the periodicity was not very high, being 30 to 40 per second, except with parallel arrangement of a condenser. **Prof Silvanus Thompson, Messrs. Deri, Korda,** and **G. Kapp** shared in the discussion.

Mr. G. Kapp treated the subject of the experimental determination of losses by Foucault currents and hysteresis in dynamos, both when running free and with full loads It was very important for electrical engineers to be able to distinguish between the losses in copper and iron from eddy currents and those for hysteresis. A simple method was described for arriving at this in the case of continuous-current machines. The losses were different when running free and when fully loaded.

Mr. W. Lahmeyer followed on the subject of new constructions in connection with rotary and continuous current machines. The author stated that the limits of high pressure of continuous-current machines depended upon the dynamos themselves, and that by the adoption of a high resistance between the armature connection with the commutator, sparking would be almost impossible, while the efficiency of the machine would be little affected. It was not improbable that by this means, and under otherwise favourable circumstances, continuous-current dynamos would be able to yield a much higher pressure than hitherto. With regard to transformers having two windings, it was advisable to insert between the high and low tension coil a kind of lightning conductor, so as to prevent the passage of the high-tension current from the primary to the secondary coil.

Mr. R. Georges, of Charlottenburg, in a paper on "Alternate-Current Motors," compared the respective merits of continuous and alternating current motors, and also referred to the advantages of the multiphase system.

Mr. Baumgardt, of Dresden, referred to the economic relations between compressed air and electricity, and raised the question as to whether the former might not be advantageously used in conjunction with the latter in so far as the working together of compressed air motors and dynamos was concerned.

Mr. Gutmann, of New York, in dealing with the practical application of the "rotary-field system," suggested the adoption of the latter term in preference to that of "rotary current." He mentioned the uses of the Tesla motor in the United States, and said that an extended adoption of that type was retarded by the high price of transformers.

THIRD SECTION.—SIGNALLING, TELEGRAPHY, AND TELEPHONY.

This section met on Tuesday afternoon, and on the proposal of Mr. W. H. Preece, Dr. Strecker was elected as chairman.

Mr. E. Berg, of Berlin, read a paper on "The Application of Electricity in the Marine." The author first criticised the arrangements made on English ships for preventing any deflection of the compass by the influence of the electric installation, and then dealt with marine signalling. He described various systems of signalling, and also an electrical steering apparatus invented by himself.

"Progress of Telegraphy and Telephony in England" was the title of a paper read by **Mr. W. H. Preece.** This was mainly an historical sketch from the period of the general adoption of the Cooke and Wheatstone double-needle instrument in 1852 down to the present time. In speaking of telephony, the author said he was unable to give such satisfactory data on that subject as he had of the progress of telegraphy. In England, he said, we were ashamed of the position of telephony, but although the telephone service was mainly in private hands, the Post Office authorities had succeeded in bring about certain improvements. **Dr. Julius Maier, Mr. Grawinkel,** and **Mr. A. R. Bennett** participated in the discussion.

The second day's proceedings commenced with a paper on "A Telephonic Time Recorder," by **Mr. Strecker**, of the Berlin Telegraph Department. He regarded as unfair the present system of charging the same amount to those who used the telephone often and to those who seldom used it. A better plan would be to charge either by the time occupied while speaking or by the number of messages. In the former case a mode of recording the time was required, and in the Telegraph Department of the German Post Office an electrical time recorder had been devised, which, he believed, would be found suitable for that purpose. With that apparatus it was found that as soon as the receiver was taken off the switch hook the instrument began to record, and continued to do so until connection was cut off.

Dr. Ubricht read a paper on "The Connection of Current Distribution in Towns with a Central Regulation of Clocks." The regulation of clocks from a central point had already been adopted in some towns, either by electrical or pneumatic means. Now, however, that the general introduction of electric mains in cities was only a question of a short time, it was desirable that the question of regulating clocks from the lighting circuits should receive attention. **Mr. Orth**, of Berlin, referred to the clock regulation system adopted there by the Urania Company. It was inconvenient to add a new network of conductors to those already in operation, and as many held that it was unsuitable to control clocks from electric light mains, the plan adopted was to regulate by means of the town telephone system.

Mr. Grawinkel, of the Berlin Post Office, dealt with the production of current for telegraphic purposes by means of accumulators. Experiments had been made at headquarters with Tudor accumulators, and as it was found that the average consumption of current was only $\frac{1}{100}$ ampere per working conductor, smaller cells had to be used.

Mr. Hummel next dealt with the determination of the magnetic and electric working of current in armature cores, and was followed by **Dr. Helm** on testing accumulators. **Prof. Thompson** described the Langdon-Davies phonopore, and was followed by **Mr. Baumann** with a communication on earth currents, and **Mr. C. Vogt** on a new precision-microphone with magnet support.

Dr. Maier read a paper on "State Control *versus* Private Control of Telephones," in which he advocated the former. He asserted that the telegraph finances in England had been injuriously affected by telephony.

FOURTH SECTION.—ELECTRO-CHEMISTRY AND SPECIAL APPLICATIONS.

This section was presided over by Mr. Quincke, of Heidelberg.

"Electro-Chemistry and Metallurgy" was the subject of a paper by **Dr. Hopfner**, who was followed by **Dr. Otten** on "The Employment of Electricity in Mining," in which the author described the various machines used in mining operations, and which were worked electrically. Cutters and drills had been the most difficult to deal with, but this matter had been successfully overcome by Mr. van Depoele. **Prof. S. Thompson** also described various electrical mining machines invented by Messrs. Atkinson and Snell.

Dr. Zerener, of Berlin, described his application of electricity to tanning. According to the author, the process was not strictly electrical in the sense that the current acted chemically upon the tanning liquor, but it hastened the tanning effect of the liquid upon the hide. He had found that continuous currents were unsuitable, and had therefore adopted alternating currents with 6,000 alternations per minute, the current being 25 amperes at 44 volts. By this process heavy hides could be fully treated in one month. This process is shown in operation at the exhibition. At the final sitting **Mr. Pfutzner** described the Siemens and Halske method of winning copper. In this process 125 h.p. was required to produce one ton of pure copper from 4 to 4½ per cent. ore.

FIFTH SECTION.—ELECTRICAL LEGISLATION.

The subject of legislation for the electrical industries was considered for the first time on Wednesday, 9th September, when various propositions were brought forward by **Messrs. Sluzewski** and **Uppenborn**, and by **Dr. May** and by **Mr. Henrich**, the last of whom suggested that a special official board should be constituted to deal with electrical installations. At this and subsequent meetings opinions differed very greatly. The final result, however, was that certain resolutions, prepared by a special committee of the section, were adopted at the concluding general meeting of the congress. These resolutions did not refer to the Electric Light and Power Bill of the German Government, but they laid down certain broad principles to ensure the efficient working of one installation without interfering with that of another.

THE TRANSMISSION OF POWER AT FRANKFORT.

The electrical transmission of power from Lauffen to Frankfort, to which we have so often referred, is thus described by the *Times* correspondent:

The most important question to be settled at this exhibition was whether the projected power transmission from Lauffen, on the Neckar, to Frankfort, a distance of 175 kilometres (about 108 English miles), would prove a practical success. I may say, without exaggeration, that the eyes and minds of electricians all over the world were turned with eager expectation, and not without anxiety, towards this city, where the results of the most momentous experiments of modern times would first be known.

It is true telegrams had been received in England to the effect that the current had been received at the exhibition, and had been employed for feeding a number of glow lamps, but nothing further was known at the time when I left London, some days ago. In order to supply your readers with the most accurate and reliable information, I decided to go to the fountain head first, and to visit Lauffen on my way to Frankfort. The little town of Lauffen is charmingly situated on the River Neckar, which separates it into two halves, connected by an old bridge, which, to say the least of it, has seen better days. The town is chiefly noted for the cement works, which, I believe, are the largest on the Continent, and have at their disposal a water power of about 1,600 h.p., derived through a separate channel from the river, about one mile above Lauffen. Of these 1,600 h.p., the cement works themselves utilise 600 by means of two Girard turbines of 300 h.p. each; a third turbine of 300 h.p. drives the dynamo generating the current for the power transmission. There is a head of water of 3·8 metres, and the turbines make 30 revolutions per minute, the dynamo 150 revolutions. The latter is coupled direct with the turbine, and is a so-called "rotation-current," or "multiple-phase current," machine, constructed by the Oerlikon Works, of Zurich. The latter company, in conjunction with the Allgemeine Elektricitats Gesellschaft, of Berlin, have divided the work between them in such a way that the Oerlikon Works have supplied the primary rotation dynamo at Lauffen and one transformer each in Lauffen and Frankfort, while the latter company has constructed the rotation-current motors, the whole of the switchboards, contrivances for regulation, and safety and measuring apparatus. At the last moment they found themselves compelled to construct two transformers each for Lauffen and Frankfort, because the Oerlikon Works, which had originally undertaken to supply the whole of the transformers, could not get them ready in time for the stipulated opening on August 15.

A detailed description of the rotation-current dynamo would lead me too far, and would involve theoretical details beyond the scope of this letter; suffice it to say that it furnishes a combination of alternating currents, specially adapted for easy and cheap transformation, and thus permitting the working of electric light and power transmission over a large area.

The machines employed at Lauffen, and also at the exhibition, have been devised by Mr. von Dolivo-Dobrowolsky, the chief electrician of the Allgemeine Elektricitate Gesellschaft, and nothing could surpass them as regards simplicity of construction and security of working. They work without brushes and without collector, and have, therefore, the additional advantage of great cheapness. The generator at Lauffen furnishes a three-phase rotation current, whose three components have an E.M.F. of 50 volts and 1,400 amperes each. The total output available for transmission is, therefore, 200 kilowatts.

From the machine the current conductors lead, in the first instance, to a switchboard provided in the usual manner with measuring instruments for E.M.F. and current, with lead safety fuses and minimum current relays making contact with an automatic switch. The latter enters into operation when the line is injured, thus cutting out the generator in case of accident. A continuous-current dynamo of the Allgemeine Elektricitate Gesellschaft, driven by a special turbine, serves as exciter for the generator and supplies its current to the latter by means of two brass wire ropes. A regulating resistance and an automatic speed regulator, constructed by Messrs. Voith, of Heidenheim, and an Oerlikon transformer complete the plant in the turbine-house. From the switchboard the current passes to the transformer just mentioned, and is there converted into a current of high pressure and small strength. It has been found that the air is not a sufficient insulator for currents of very high pressure, and the transformers have therefore been placed in vessels filled with oil. The transformers have a capacity of 200 kilowatts, and the converted current starting from Lauffen has an E.M F. of 15,000 volts at about 12 to 13 amperes. The current is conveyed from the generator to the transformers by stout cables of 27 mm. diameter. There are altogether three transformers installed at Lauffen, one for use, and the two others for reserve.

For transmission of the converted high-pressure current three thin bare copper wires of not more than 4 mm. diameter are sufficient. And here arises a convenient opportunity for pointing out the recent progress made in the electrical transmission of energy, which has for the first time been applied on a large scale (transmissions on a small scale based on these principles had previously been successfully carried out by the Oerlikon Works) to the Lauffen-Frankfort transmission, and has, as I shall show further on, led to its final success.

It will probably be in the recollection of your readers that Marcel Deprez carried out an electrical transmission of energy between Munich and Miesbach, a distance of about 60 kilometres (about 37 miles), at the Munich Electrical Exhibition in 1882. For the purpose of this transmission no conversion of current was made; a continuous-current generator furnished a current of 2,000 volts, which was led from Miesbach to Munich, and there actuated a motor of similar construction to the generating dynamo, and no special precautions were taken as regards the insulation of the line. In the Lauffen-Frankfort transmission the current generated is one of low E.M.F. and great strength, which is, in the first instance, converted into one of high E.M.F. and small strength, and thus conveyed to the place of consumption.

This arrangement allows, first of all, the employment of a generator of the simplest possible construction, with a transformation involving a very slight loss indeed, amounting to less than 5 per cent., and, secondly, the converted current requires for transmission a wire of very small diameter (only 4 mm.), and thus renders the transmission practicable from an economical point of view. And, thirdly, the use of oil insulators, both for the transformers and for the line wires, reduces the losses occurring over a distance of more than 100 miles to a figure not exceeding 25 per cent. of the original energy. In the case of the Miesbach-Munchen transmission these losses exceeded 50 per cent.

After this digression I return to the subject in hand.

The line wires, of 4 mm. diameter, are erected in the same way as ordinary telegraph lines. The poles to which they are attached are eight metres in height and placed at distances of about 60 metres from one another. The number of poles employed amounts to about 3,000; the necessary copper wire, of about 530 kilometres length and 60,000 kilogrammes weight, has been lent by Messrs. F. A. Hesse and Sons, of Heddernheim, in the interest of this highly important experiment. The erection of the line was very much facilitated by the active support and co-operation of the Governments of Wurtemberg, Baden, and Hesse, through whose territories the line had to be led. The Allgemeine Elektricitate Gesellschaft and the Oerlikon Works have, in addition to the above-named machines and apparatus, also supplied the very expensive oil insulators. These were manufactured after the type of the well-known Johnson and Phillips insulators, by Messrs. Schomberg and Sons, of Berlin. They differ from the insulators commonly used in telegraph lines by being provided with one or more troughs filled with oil. Porcelain itself is a very good insulator, even for high-pressure currents, but on the surface of the insulator moisture is condensed, which not only diminishes the insulating capacity very considerably, but also causes the formation of a coating of dust and dirt, which still further diminishes the insulation. For a few thousand volts, insulators the cup of which is bent inwards at the bottom, thus forming one trough, have proved thoroughly efficient, but for higher pressures three troughs are formed inside the insulator cup.

The line projected by Mr. Ebers follows the following route: Lauffen, Heilbronn, Jagstfeld, Eberbach, Erbach, Babenhausen, Hanau, and Frankfort. Between Lauffen and Eberbach, about one-third of the whole distance, the large insulators with three troughs have been used, but time being too short to manufacture the remaining 9,000 insulators after the same model, insulators of the smaller type, with one trough only, had to be employed.

At the Frankfort Exhibition the high-pressure wires are led to three oil transformers like those in Lauffen. One of these, constructed by the Oerlikon Works, reduces the pressure to about 100 volts at a corresponding increase of current. This transformer is located on the left of the main entrance of the distribution hall. It furnishes the current for feeding 1,200 glow lamps, partly fixed to a large frame in the transformer-room, partly to a sort of signboard outside the hall. The remainder of the current, corresponding to about 100 h.p., is reduced to the requisite E.M.F. of 100 volts by two transformers of the Allgemeine Elektricitate Gesellschaft. These two transformers are located in a special shed on the right of the hall. The secondary currents furnished by them serve for operating a large rotation-current motor of the Allgemeine Elektricitate Gesellschaft, as well as some other smaller motors of the same company. The large motor makes 600 revolutions per minute, and is coupled direct to a centrifugal pump, built by Messrs. Brodnitz and Seydel, of Berlin, which supplies a waterfall of 10 metres height on the right of the hall. Thus we see one portion of the electrically-transmitted energy transcribe a perfect circle. A waterfall at Lauffen is the starting point of the energy, and part of this latter is again brought before our eyes in the form of a waterfall at Frankfort.

And now I come to the results actually obtained by this all-important experiment. Nine hundred glow lamps have been burning regularly since the current was first switched on on August 25, and this number has been increased to 1,100. As regards the motor for operating the waterfall, it worked for a short time after starting, but in consequence of a slight defect in the motor—contact between a copper conductor and the iron of the motor—it soon became heated and had to be dismounted, and was taken away for repairs. I convinced myself at Lauffen that the generator there was only running at little more than one-third of its normal load (100 h.p.), and of these 100 h.p. about 80 are represented by the 900 glow lamps burning regularly. I think I am within the mark in stating that the useful energy recovered in Frankfort is about 75 per cent. of the energy expended in Lauffen.

In view of the enormous pressures employed in the transmission (it is intended to use potentials of from 12,500 to 25,000 volts), the most elaborate precautions had to be taken, for currents of such high potential are absolutely fatal. The measures of precaution taken to prevent any accident are of such a kind that they appear to exclude any risk whatever unless wilfully tampered with. The transformers in Lauffen as well as in Frankfort are placed in buildings inaccessible to the public during working hours, and the lines have been led along the railway tracks to remove them from interference on the part of the public. Both at Lauffen and at Frankfort they have been protected against lightning effects, and at both termini, as well as at certain intermediary stations, efficient safety contrivances have been constructed. Finally, there are at both end stations measuring instruments which immediately indicate any irregularity in working, and, if needs be, automatically interrupt the current. These safety contrivances were, on September 2, tested by Wurtemburg Government officials in Lauffen, and the disturbances such as might occur on the line by the entanglement, the falling down, or breaking of wires were purposely brought about. By the entanglement of the lines and the short circuit caused thereby, the safety cut-outs in the machine-room were immediately melted and interrupted the current. One or more broken wires immediately actuated the current relays mentioned above, and the automatic switches cutting the machine out of circuit. On placing the wires on the rails of the railway line the relays and switches again were set in operation with the same effect. Mr. von Dolivo-Dobrowolsky told me himself that he removed the wires from the rails with his walking stick; he was very much alive when he told me so.

I do not think that I am guilty of exaggeration in expressing an opinion that the Lauffen-Frankfort transmission is the most difficult and most momentous experiment made in technical electricity since that mysterious natural force which we call electricity has been made serviceable to mankind.

COMPANIES' REPORTS.

BRUSH ELECTRICAL ENGINEERING COMPANY, LIMITED.

Directors: His Grace the Duke of Marlborough, chairman; Mr. J. B. Braithwaite, jun. (of Messrs. Foster and Braithwaite); Mr. Aymor H. Sanderson; Colonel Frederick George Steuart; Mr. B. H. van Tromp; Mr. Edward Woods (Past President Institution of Civil Engineers); Mr. E. Garcke, managing director.

Second annual report to be presented to the shareholders at the general meeting of the Company to be held at Cannon-street Hotel, E.C., on September 25, 1891, at 3 p.m.

The Directors beg to submit the balance-sheet and profit and loss account for the year ended June 30 last. The profit and loss account shows a gross profit of £42,712. 8s. 10d., inclusive of the amount brought forward from last account, but exclusive of any profit derivable from the City of London electric lighting undertaking. After deducting all standing charges, etc., maintenance of plant, buildings and patents, and interest on debentures, there remains a balance of £19 354. 2s. 1d. It is proposed to apply £630 to reduction of preliminary expenses, and to reduce property, patents, and goodwill account by £3,000. An interim dividend, absorbing £4,199. 15s. 2d., has already been paid upon the preference shares for the six months ended 31st December last, and it is proposed to apply £4,199. 15s. 2d. to the payment of a further dividend upon those shares, making up the full preferential dividend at the rate of 6 per cent. per annum. The Directors further recommend that a dividend be paid upon the ordinary shares of the Company at the rate of 6 per cent. per annum for the half-year ended 30th June last, and that the balance of £306. 11s. 5d. be carried forward to next account. It is proposed to make the dividends on both the preference and the ordinary shares payable on 1st October next. The accounts include the returns from the Australasian branch made up to the 30th April last. The business of the branch is now established on a satisfactory basis, and the result of the working shows a small profit. The capital account has during the year been increased by £5,000, being the amount of fully-paid shares issued to the Australasian Company in completion of the purchase of their stores and other assets in Australia. The property account stood at the date of the last balance-sheet (after writing off £3,000) at £294,400 8 10

	£	s.	d.	£	s.	d.
During the year the account has been increased by—						
Proportion of shares issued to the Australasian Company, and cost of establishing branch	£1,918	10	6			
Additions to buildings, plant at Loughborough and other places...	5,226	2	4			
Expenditure on new patents and developments	564	2	1			
				7,708	14	11
				£302,109	5	9
The account has been reduced by—						
Sales of properties, amortisation of leases and proportion of compensation received from South-Eastern Railway..................	13,294	3	3			
Amount this year included in balance-sheet of foreign and colonial branches	22,544	2	8			
				35,838	5	11
The account now stands at..............................				£266,270	19	10

During the past year sums amounting to £21,070. 18s. 1d. were expended upon the City of London electric lighting undertaking, arrangements having been made with a provisional company called the City of London Electric Lighting (Pioneer) Company for the carrying on of the work. Since the closing of the books the whole of the interests of the Brush Company in the City of London electric lighting undertaking have, with the consents of the Board of Trade and the Commissioners of Sewers, been transferred to a larger company called the City of London Electric Lighting Company. As, however, the transfers were not completed until August 21, no profits on the large amount of work done have been included in the profit and loss account to June 30. In consideration of this transfer the Brush Company has received contracts for the equipment of the central stations, amounting in the aggregate to over £300,000, to be executed by instalments as specified by the City Company. A satisfactory profit will accrue from the carrying out of these contracts, and an amount of about £53,650 is now payable to the Brush Company on account, in addition to £25,700 already received. A strip of land adjoining the Lambeth Works has been sold to the South-Eastern Railway Company in consideration of the payment of £6,500. A portion of this amount has been applied to reduction of property account, and the balance has been placed to a reserve account to meet the expenses caused by the disturbance. The main factory premises will not be affected by this sale of land, but the present office accommodation of the Company will be much curtailed, and the Board have decided to take the opportunity of removing the head offices to the City. The Bournemouth undertaking, consisting of provisional order, land, buildings, and plant, has been transferred to a local company in consideration of the sum of £17,275, which has been paid partly in cash and partly in fully-paid shares of the Company, and the stores have been sold for cash at a valuation. As part of the arrangement, this Company has guaranteed a minimum dividend of 5 per cent. per annum for three years upon the capital of the Company, not exceeding £30,000. The profit on the sale has been placed to the reserve account. The Austro-Hungarian business continues to increase and to give satisfaction, and the new factory at Vienna will shortly be completed. The negotiations for a rearrangement of the Company's interest in the business are still pending. The volume of the Company's business in the manufacture and installation of electrical apparatus and in the construction of steam engines, and of rolling-stock generally, continues to increase, and the prospects for the current year are encouraging. Besides the work to be done for the City Company, several other important contracts have been secured which should result in profits to the shareholders. The large amount of work in hand and in view has demonstrated the wisdom of acquiring and extending the Falcon Works, as without these additional manufacturing facilities the Company would not have been able to undertake the carrying out of these large central station contracts. Owing to pressure of other engagements, Lord Thurlow felt compelled to resign his seat at the Board and the chairmanship of the Company, and his Grace the Duke of Marlborough has succeeded him as chairman. The Directors also regret the retirement from the Board of Mr. John S. Sellon on account of his health. Mr. E. Garcke, formerly manager and secretary, has been appointed managing director. The Duke of Marlborough and Mr. Sanderson retire by rotation and offer themselves for re-election. Messrs. Cooper Bros. and Co., the auditors, offer themselves for re-election.

BALANCE-SHEET, JUNE 30, 1891.

Dr.	£	s.	d.	£	s.	d.
Authorised capital	750,000	0	0			
Capital issued—viz.:						
69,996 6 per cent. preference shares of £2 each	139,992	0	0			
77,978 ordinary shares of £3 each	233,934	0	0			
	373,926	0	0			
Less calls in arrear	2	10	0			
				373,923	10	0
6 per cent. mortgage debentures...				75,000	0	0
Creditors.						
Sundry creditors	41,630	14	4			
Bills payable..	18,898	4	10			
				60,528	19	2
Advances from City of London Electric Lighting (Pioneer) Company and others against City undertaking				34,892	15	7
Reserve account				4,275	16	2
Balance of profit and loss account	19,354	2	1			
Less interim dividend paid on preference shares	4,199	15	2			
				15,154	6	11
Note.—Contingent liability in respect of uncalled capital on shares in other companies and on bills receivable discounted... £10,886 8 4						
				£563,775	7	10

Cr.	£	s.	d.	£	s.	d.
Property, patents and goodwill—For value of plant, freehold and leasehold land and buildings at Loughborough, in Leicestershire, at Lambeth, Borough-road, and Hammersmith in London, at Edinburgh, Cardiff and Manchester, and of English, Foreign and Colonial Brush, Edison, and other patents, and of goodwill of the Anglo-American Brush Electric Light Corporation, the Falcon Engine and Car Works, Limited, and the Australasian Electric Light and Power Company				266,270	19	10
Stock—Goods in hand in process of manufacture and materials at London, Loughborough and other places				78,326	6	3
Debtors—Sundry accounts (after provision for doubtful debts)......	87,041	10	1			
Bills receivable..	5,612	11	9			
				93,263	1	10
Cash at bankers and in hand.........				7,062	3	11
Shares and debentures in other companies				28,914	0	0
City of London electric lighting undertaking...				21,070	18	1
Provisional orders account...........				989	4	0
Preliminary expenses, 1889-90	1,886	15	8			
Written off last year	625	0	0			
				1,261	15	8
Liquidators' balances and suspense accounts				2,086	13	3
Balance of foreign and colonial branches accounts, being excess of assets over liabilities				64,530	5	0
				£563,775	7	10

PROFIT AND LOSS ACCOUNT FOR THE YEAR ENDED 30TH JUNE, 1891.

Dr.	£	s.	d.	£	s.	d.
General charges—viz.:						
Directors' fees	1,875	0	0			
Auditors' fees	52	10	0			
Salaries	7,222	7	0			
Staff bonuses..............................	759	7	9			
Law charges	584	18	1			
Insurance	770	14	0			
Postage, stationery, and printing...	1,282	8	10			
Travelling, carriage, and freight...	652	2	4			
Advertising, agency, and sundries.	2,238	14	1			
Income tax..................	348	15	3			
				15,786	17	4
Share and debenture expenses				108	18	0
Loss on closing Cardiff station				447	7	3
Maintenance of plant and buildings				2,184	17	7
Maintenance of patents				487	19	2
Interest on debentures to 30th June, 1891				4,351	7	5
Balance, being net profit..				19,354	2	1
				£42,712	8	10

Cr.	£	s.	d.
Balance from last account	2,796	14	9
Gross profit, including net profit of foreign and colonial branches	39,915	14	1
	£42,712	8	10

APPROPRIATION ACCOUNT.

Dr.	£	s.	d.
Further dividend on preference shares	4,199	15	2
Dividend on ordinary shares at the rate of 6 per cent. per annum for six months	7,018	0	4
Reduction of property account	3,000	0	0
Reduction of preliminary expenses	630	0	0
Balance carried forward	306	11	5
	£15,154	6	11
Cr.	**£**	**s.**	**d.**
Balance	15,154	6	11
	£15,154	6	11

BALANCE-SHEET OF THE FOREIGN AND COLONIAL BRANCHES.

Being the balances of the following accounts: Vienna (made up to December 31, 1890), Temesvar (made up to June 30, 1891), Australia (made up to April 30, 1891).

Dr.	£	s.	d.	£	s.	d.
Creditors—						
Open accounts and bills payable	26,267	10	4			
Unpaid balance of purchase price of land secured by mortgage	7,505	6	8			
				33,772	17	0
Balance of assets over liabilities transferred to general balance-sheet				64,530	5	0
				£98,303	2	0

Cr.	£	s.	d.
Property—For freehold and leasehold lands, buildings, plant, tools, fixtures, etc, at Vienna, Temesvar, and in Australia	36,820	1	11
Stock—For goods in hand, in process of manufacture and materials	33,246	7	10
Debtors—Sundry accounts (after provision for doubtful debts) and bills receivable	27,205	5	4
Cash—At bankers and in hand	828	17	4
Shares in other companies	10	0	0
Australian suspense items	192	9	7
	£98,303	2	0

CITY NOTES.

Brazilian Submarine Telegraph Company.—The receipts for the past week were £4,430.

City and South London Railway.—The receipts for the week ending 13th inst. were £664. The aggregate receipts for the half-year ending same date were £7,523

Western and Brazilian Telegraph Company.—The receipts for the week ended Sept. 11, after deducting 17 per cent. of the gross receipts payable to the London-Platino Brazilian Company, were £2,971.

Brush Electrical Engineering Company, Limited.—At a meeting of the Directors of this Company, held on the 14th inst., it was resolved to recommend the payment of a dividend on the preference shares of the Company, and also a dividend on the ordinary shares, both at the rate of 6 per cent. per annum, for the six months ended June 30, 1891.

Morecambe Electric Light and Power Company.—This Company has been formed with a capital of £15,000, divided in 50 founders' and 14,950 ordinary shares of £1 each, for the purpose of supplying electric light and motive power in Morecambe and district. After 7 per cent. has been paid on the ordinary shares, the surplus is to be divided one-third to founders, one-third to reserve, and one-third as further dividend on the ordinary shares.

PROVISIONAL PATENTS, 1891.

SEPTEMBER 7.

15075. **An improved portable electric lamp.** Robert Thompson and Horace Seymour Pyne, Castletown, Isle of Man.

15094. **Improvements in the manufacture of leaves for lamp, candle, or electric light shades.** Howard Trotman, 228, Euston-road, London.

15096. **Improvements in feed mechanism in relation to arc lamps.** Albert Augustus Goldston, 3, MacDowall-road, Knatchbull-road, Camberwell, London.

15123. **Improvements in or connected with systems of electric distribution wherein electrical storage batteries are used.** Henry Edmunds, 47, Lincoln's-inn-fields, London.

15125. **Improvements in electrical storage cells and elements therefor.** Alfred James Jarman, 11, Furnival-street, Holborn, London.

SEPTEMBER 8.

15162. **The improved medical electrode or electro-medical battery.** Mary Ann Hillock and Everard Venable, 41, Berners-street, London.

15206. **Improvements in phonographs.** George Edward Gouraud, 191, Fleet-street, London. (Thomas Alva Edison, United States.)

15214. **Improved construction of telephone receiver.** Richard Robert Harper, 166, Fleet-street, London.

15240. **An improvement in bobbins for dynamo-electric machines.** Siemens Bros. and Co., Limited, and Francis Hird, 28, Southampton-buildings, London.

SEPTEMBER 9.

15268. **An improved miners' electric safety lamp.** John Havard Thomas, Bristol Bank-buildings, Bristol.

15276. **An electric apparatus for the purpose of starting races of all kinds.** Thomas Johnson and Jules Gindraux, Mitton Villa, Hainthorpe-road, West Norwood.

15299. **Improvements in electrical signalling apparatus, chiefly designed for police service.** William Robert Lake, 45, Southampton-buildings, London. (The New Haven Clock Company, United States.) (Complete specification.)

SEPTEMBER 10.

15321. **An improved electrical regulator or governor.** Ernest Alexander Claremont, 246, Moss-lane East, Manchester.

15337. **An improvement in standard electrical condensers.** Alexander Muirhead, 124, Chancery-lane, London. (Complete specification.)

15363. **Improvements in alternating-current motors.** Henry Charles Edward Jacoby, 21, Finsbury-pavement, London.

SEPTEMBER 11.

15377. **An improved electric globe gallery and shade holder.** John Whitehead, 42, Anglesey-street, Lozells, Birmingham.

15403. **An improved method of actuating electrically-propelled tramcars, partly applicable to other purposes.** Wilfrid Swanwick Boult, 60, Castle-street, Liverpool.

15407. **Improvements in galvanic batteries.** Gustavus Cohen, 60A, Market-street, Manchester.

15432. **Improvements in electrical igniting apparatus.** Thomas Parker and William Armistead, 47, Lincoln's-inn-fields, London.

15440. **Improved apparatus for periodically passing currents of electricity through a conductor.** Robert Harkness Twigg, 6, Bream's-buildings, London.

SEPTEMBER 12.

15480. **Improvements in or relating to dynamo-electric machines.** William Phillips Thompson, 6, Lord-street, Liverpool. (Louis Dahlmann and Fritz Kirster, Germany.)

15483. **Improvements in electric lighting and the means therefor.** John Clayton Mewburn, 55, Chancery-lane, London. (Paul Sée, France.)

SPECIFICATIONS PUBLISHED

1889.

11589. **Electric conductors, etc.** Crompton. (Second edition.) 8d.

1890.

12874. **Electric switch.** Bonne (The Actien Gesellschaft Mix and Genest). 8d.

12914. **Electric Switches.** Jarman. 8d.

13123. **Electricity meters.** Hookham. 8d.

15819. **Electric dynamos, etc.** Johnstone. 8d.

[illegible]. **Holding telephone receivers, etc.** Thompson (Moore). 8d.

17402. **Electrical conductors.** Cook and others. 8d.

17611. **Electrical push button for signalling circuits.** Abel (Messing). 6d.

18896. **Making copper tubes, etc., by electrolysis.** Elmore. 8d.

1891.

6847. **Printing telegraphs** Linville and Hettmansperger. 2s. 10d.

11133. **Dynamo-electric machines, etc.** Lake (The Crocker Wheeler Electric Motor Company). 8d.

11473. **Electromagnetic motors.** Lake (Tesla). 8d

12069. **Electrodes for secondary batteries.** Fitzpatrick (Scheller and another). 6d.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Brush Co.	—	2¼
— Pref.	—	2
India Rubber, Gutta Percha & Telegraph Co.	10	19½
House-to-House	5	5
Metropolitan Electric Supply	—	10
London Electric Supply	5	1⅞
Swan United	[illegible]	4½
St. James'	—	[illegible]
National Telephone	5	4¾
Electric Construction	10	7¼
Westminster Electric	—	5½

NOTES.

Zinc.—A new factory for the wholesale manufacture of zinc is about to be established at Soumagne in France.

Blackpool Railway.—The high tides at Blackpool last week washed over the promenade and stopped the electric trams.

Glasgow Tramcars.—It is understood that the Glasgow Corporation intend placing on their lines 100 accumulator cars, as used on the Barking-road line.

Chelsea Electric Station.—The plant at the Chelsea electric light station, Draycott-place, is being remodelled, and fresh and more powerful machinery is being added.

Lyceum.—In the Lyceum Theatre the footlights and the entire auditorium have been fitted with electric light, the current being supplied from the Electricity Supply Company.

Heat Engine.—Messrs. Edmundson's, of London and Dublin, have on view at their Dublin office a Bailey-Friedrich motor, driving a dynamo for a small installation of electric light.

Church Lighting at Bournemouth.—It has been resolved to adopt the electric light in Holy Trinity Church, Bournemouth. The system will be similar to that at the Temple Church, London.

Battersea.—The Battersea Vestry has appointed a special committee to consider and report upon the question of lighting the parish by electricity, the cost, advisability, and course to be adopted.

Glasgow Branch.—Messrs. Woodhouse and Rawson United, Limited, inform us that they have just opened a branch at Glasgow under the management of Mr. B. F. Howard, who is appointed their agent for Scotland.

Heating Railway Cars.—Two French engineers, MM. Courcelles and Elu, are attempting to introduce a method of warming railway carriages by the heat radiated from a grate of leaden bars through which current is passed.

Nelson (Lancs.).—The Nelson Town Council have received orders for the 600 lights which they required to be guaranteed preparatory to providing the electric light for public use, and prompt measures will now be taken to supply the light.

Eastbourne.—As we surmised, the figure 100 c.p. in the report given in our last issue is an error, and the figure should have been 1,000 c.p. The arc lamps referred to are 2,000 c.p. nominal, and, as is usual, are taken to be about 1,000 c.p. actual.

Lightning Conductors for Bombay.—Mr. Jos. Blackburn, of Nottingham, has been awarded the contract for the whole of the lightning conductors for the new Municipal Buildings, Bombay, and they are now being specially made by him.

Private Lighting.—Mr. Kemp-Welch has had the electric light at his residence at Sopley, near Ringwood (Hants), for some time. The River Avon passes by Sopley, and not only does the old mill grind the corn, but the same waterwheel creates light for the large house.

Railway Stores.—Tenders are to be given out on October 5 for railway stores, amongst other materials for telegraph wires and instruments, by the Lancashire and Yorkshire Railway. Particulars can be obtained on application at the Store Department, Osborne street, Manchester.

Mill Lighting.—We are informed by W. Farrar, the London agent for Wilson Hartnell, Leeds, that he has secured the order for the electric lighting of the new flour mills for Messrs. James Tucker, Limited, Cardiff. When complete these premises will rank amongst the largest in the country.

Electric Cycle Lamp.—We see it stated that an electric cycle lamp, weighing no more than the oil lamp "King of the Road," is being introduced. The inventor is Mr. George L. Gowlland, and the patents (of course, there are patents and a company to follow) belong to the Gowlland Light Syndicate.

Rome.—The town authorities of Rome have under consideration a request for the concession of a series electric railway, which is intended to connect together the squares Populi, Venezia, San Petro, Strozzi, and Transtevere. The company will be distinct from that which obtained the concession for the Tivoli tramways.

Electric Clocks.—For those interested in the question of electric clocks an article in the *Ingenieur Conseil* of Brussels for September 20 may be useful. The Vande Plancke system used by the Société Anonyme des Horloges Electriques de Saint-Nicholas (Waes) is described, showing regulation through many different clocks.

African Telegraphs.—A number of German officials have started to East Africa to run a 250-mile telegraph line. The poles are made by the Austrian Manesmann Pipe Works, being steel tubes in halves, one half of which slips inside the other. The Manesmann Works have already received other orders from abroad.

Edinburgh.—At a meeting of the Lord Provost's Committee of the Edinburgh Town Council on Wednesday, September 16, a letter was read from Messrs. George Deas and Co., St. Andrew-square, submitting a prospectus of the Edinburgh Electric Supply Corporation, Limited, and was remitted to the Electric Lighting Sub-Committee.

Opera by Telephone.—Last Friday night the Prince of Wales Theatre, Birmingham, was connected by telephone with numerous places in Worcester, and the comic opera, "The Nautch Girl," was heard by numerous small and widely separated audiences in Worcester. The experiment was very successful, the different numbers being heard very distinctly.

Mauritius Cable.—A cable having been projected by the French colony at Mauritius to pass through one of the Diego Suarez islands, Tamatave, and Réunion, the English governor has refused his permission, for the reason that in case of war Mauritius would be at the mercy of France for its news, and has insisted on the line going by way of Mahé and Zanzibar.

Westminster Company.—The Westminster Electric Supply Corporation's stations at Belgravia and Mayfair are both working. The stations, however, are not completely finished, and are not yet even out of the builders' hands. The continued and increasing demand for house lighting in these districts speaks exceedingly well for the prospects of the company.

Electric Light in Egypt.—The British Consul at Alexandria reports officially that it is intended shortly to introduce the electric light in the Alexandria-Cairo express, and it is probable that before long the railway termini will be lighted by electricity. One agency for the electric light is established at Alexandria, but as yet only a few establishments have adopted it.

Vibration. — The Amalgamated Dairies Company, Limited, have applied for an injunction against (Gatti's) Electricity Supply Company to restrain them from causing a nuisance by their machinery. Affidavits were produced from 11 different people to testify as to shaking windows and the impossibility of a good night's sleep. The case was ordered to stand over the vacation.

Old Students' Dinner.—The annual dinner of the Old Students' Association of the City and Guilds of London Institute will take place at the Holborn Restaurant on Saturday evening, October 3rd, at 7 o'clock. Each member has the privilege of introducing one friend. The tickets (4s. 6d. each) can be obtained from the hon. secretary, 88, Queen Victoria-street, E.C. A large gathering is expected.

Glasgow Councillors to Visit Frankfort.—In view of the introduction of the electric light by the Corporation of Glasgow, and also of the adoption of electricity for tramway propulsion, it is understood that a proposal to send a deputation to visit the Frankfort Electrical Exhibition is under consideration, this being the most complete and advanced undertaking of the kind yet held.

Accrington.—The Accrington Town Council some time ago had the question of transfer of the gas plant brought before them. They afterwards appointed a committee to go into reported irregularities of the gas company, and the Parliamentary Committee now recommend that it is desirable that the Corporation should proceed forthwith to establish an electric central station, under the power of their provisional order obtained last year.

Chicago Exhibition.—Sir H. Trueman Wood and Mr. Dredge, the British Royal Commissioners for the Chicago Exhibition, have selected as the site for the British Government building the prettiest spot in Jackson Park, situated on the shores of the lake, and commanding splendid views of the exhibition buildings and grounds in every direction. The Building Committee has confirmed their choice, and granted the site selected.

Contracts.—The following contracts, which are shortly to be decided, may be useful field for electrical engineers: Carlisle, new public library, Mr. W. Howard Smith, city surveyor; Blackpool, new promenade pier for the Blackpool South Shore Pier Company; Bristol, extension of the Avonmouth Docks, Mr. J. McCurrick, engineer, Cumberland Basin, Bristol; Downpatrick (Ireland), new water works for the Guardians; Pimlico, new pumping station for the London County Council.

Sea-Water Battery.—The indefatigable M. Trouvé has been astonishing the French Academy of Sciences by his design for an electric boat propelled by a sea-water battery. The plates are sunk in the sea under the boat by way of a kind of keel, and drive a large rotary wheel by means of a motor. Pulleys raise or lower the plates of zinc or copper as required. Interesting as a scientific *tour de force*, it is hardly likely, we should fancy, there will be much use in this proposal.

Pisa.—The electric lighting for the town of Pisa is offered for public contract. The scale of charges contains a peculiarly stringent clause with reference to stoppages. For each interruption of current of one quarter of an hour a fine will be enforced on a sliding scale, according to current, from 5f. to 1,000f.; if two occur in the same month it may rise to 2,000f. The conductors for this central station may be overhead or underground, but in the second case they will require to be placed 22ft. beneath the surface.

Copper.—The supply of copper has been increasing with great strides: 1887, 223,078 tons; 1888, 258,026 tons; 1889 (notwithstanding the collapse) 261,650 tons; and 1890, a further jump to 269,685 tons. The most striking expansion is in America—25,010 tons in 1880 to 116,325 tons in 1890. With regard to prices, in 1880 it was £63 per ton, in 1885 it had fallen to £44, and in the following year it reached its lowest of recent years, £40. 6s. In 1888 it sprang to £76, and in 1890 the price was £54 per ton.

Electrical Fire Calls for Taunton.—Tenders are invited for supply and erection of electrical fire calls within the borough, for the Taunton Town Council. Plan, specification, and other information may be obtained at the office of the water works manager, Municipal Buildings, Taunton. The contractor must be prepared to give securities for carrying out the contract if required to do so. Sealed tenders, endorsed "Tender for Fire Calls," to be sent by October 5, addressed to Mr. T. Meyler, town clerk, Taunton.

The New Postmaster-General.—The important position of Postmaster-General of Great Britain, left vacant by the death of Hon. Cecil Raikes, has been accepted by Sir James Fergusson. He was born in Edinburgh, in 1832, educated at Rugby and Oxford, served in the Crimean campaign, has been Under-Secretary for India and for the Home Department; he was appointed Governor of South Australia in 1868, and in 1873 became Governor of New Zealand; from 1880 to 1885 he was Governor of Bombay, and since then has been Under-Secretary for Foreign Affairs.

Crystal Palace Company.—The Board of Trade have informed the Lewisham District Board of Works, with respect to the Crystal Palace and District Electric Lighting Order, 1890, that the undertakers have satisfied the Board of Trade that they are in a position fully and efficiently to discharge the duties and obligations imposed upon them by the order throughout the area of supply, but asking for any observations which the Lewisham Board desired to make thereon. The matter was referred to a committee to consider the question of a uniform system of laying the wires.

Electric Buttonhole Lamps.—The great omnibus strike seems to have brought out a new field for electric lamps, if we are to believe a statement in the evening papers. Tickets are now compulsory on all omnibuses, and an army of inspectors examine them. At night this is difficult, and several electric omnibus inspectors now possess a small electric buttonhole lamp, which is worked by a pocket battery. On asking for the passengers' tickets the inspector has only to touch the battery, and a vivid light reveals the number and particulars of the printed slip. The idea is still in the experimental stage.

City Lighting.—The first meeting of the City Commission of Sewers since the recess was held on Tuesday at Guildhall, Mr. S. Scott presiding. In relation to the electric lighting of the City, the chairman reported that during the recess he and the solicitor had, at the request of the Board of Trade, satisfied themselves as to the due constitution and the adequate subscription of the capital of the City of London Electric Lighting Company, and they saw no objection to the proposed transfer of the contracts from the Brush and other companies to that company. The Commission approved this decision.

Dufftown.—The good people of Dufftown are emulous of the movements of those of Inverness, alluded to last week. At the meeting of the Police Commissioners on Monday, Provost Symon proposed that, in view of the future lighting of the town, a competent electric engineer be employed to report on the adaptability and economy of electric lighting for the town. The motion was agreed to, and the clerk was instructed to ascertain from the town clerk of Inverness the name and address of the engineer employed to report on the feasibility of lighting Inverness with electricity, and also to obtain all other available information.

Liverpool Electrical Engineer.—Mr. Charles H. Yeaman, the electrical engineer to the city of Liverpool, has resigned his position to take up the engineership of a large local company. He has completed to his designs and superintendence an electrical laboratory, which will place the Liverpool Corporation in a position to obtain the most accurate results in electric measurement, and this has been done at the small cost of less than £1,000. Before completing his design, Mr. Yeaman visited the principal laboratories in this country, and has adopted many points of interest. There are 93 applications before the Corporation for this position.

Telephone Extension.—The National Telephone Company has just erected an additional trunk wire between Perth and Dundee, in order to provide for the increased traffic and to facilitate through communication between Perth, Glasgow, Edinburgh, and the South. The additional trunk wires from Dundee to Glasgow and Edinburgh are now in course of erection. A number of new trunk wires have been erected in Fifeshire to meet growing requirements, and an additional trunk communication is about to be provided between Dundee and Arbroath. The new trunk line from Newcastle to the Midlands and London will be opened in October.

Certificates.—The manager of the Hanover-square School of Electrical Engineering, Mr. L. Drugman, M.I.E.E., informs us that, as the result of the examination for the vellum certificate of the school held in August, the following gentlemen have obtained the certificate in electric lighting and power transmission: Messrs. G. Boa, J. L. Chambers, W. M. Hartin, G. Johnson, and W. B. Lock. This examination was conducted by Mr. Gisbert Kapp, M.I.C.E., M.I.E.E., and consisted of a paper in mechanical engineering, a paper in electrical engineering, a *viva-vôce* and practical examination, and drawing. All these students belonged to the advanced class; instructor, Mr. Charles Capito, M.I.M.E., M.I.E.E.

New Zealand.—Mr. Postlethwaite, the representative of Messrs. Crompton and Co., is opening up a new field for small arc lighting plants. He has installed a two arc Crompton plant to light the gold-mining operations of the Roxburgh Amalgamated Company. The dynamo will be driven by a Pelton waterwheel. We understand also that a somewhat similar plant is to be sent out for the Round Hill Syndicate. In that case we believe a compound-wound 110-volt dynamo, to give 45 amperes at 1,600 revolutions, is to be used, as it will perhaps be required for incandescent lighting sometimes and arc lighting at others. It is said that the usual output in many mines will be trebled by using the electric light and working three shifts.

Telephoning in the Western Counties.—The telephone has made wonderful progress in the West of late, due to the continued energy of the Western Counties and South Wales Telephone Company. Exchanges at Plymouth, Devonport, Mutley, Avonwick, Plympton, Ivybridge, Torquay, Paignton, Newton Abbot, Totnes, Dartmouth, Brixham, Buckfastleigh, and Ashburton are now in direct inter-communication with each other, and the tolls in the different cases vary, as a rule, from fourpence to sixpence. The trunk line between Plymouth and Exeter is now complete, and when the line is open subscribers in Plymouth will be able to speak to any subscriber at Exeter on payment of a toll of sixpence, and which will entitle him to three minutes' conversation. Non-subscribers will be permitted to speak over the line from any of the call-rooms in the different towns.

Cost of Electric Traction.—The figures recently published of the cost of traction on the West End Street Railway of Boston give some interesting results showing the gradual decrease of cost per car mile. In April and May last the cost came out 10·86 cents (5·43d.) per car mile, while in June and July it was 10·38 cents (5·19d.). The motive power has since been reduced to 7 cents (3½d.) per car mile, and still shows a tendency to get lower. The earnings in July were 19·16d. per mile run; total expenses, 10·24d. per mile run (power 3·5d., repairs, 0·58d., damages ·06d., drivers 3·46d., other expenses 2·68d.). The percentage of operating expenses to gross receipts was 53·44 per cent., as against 66·58 per cent. for horse traction.

High-Speed Travelling. — The proposed Weems express must look to its laurels, or the railway will beat it after all. Some extraordinary records were made on August 27 on the Bound Brook line, New Jersey, where engine 206, Wootten model, with large furnace burning anthracite coal, drawing a train of three cars (two ordinary passenger coaches and a private car) made the mile in 39⅘ seconds, and 10 consecutive miles at 43 seconds per mile. This mile run is at the rate of 90·45 miles an hour, and the 10 mile run at 83·72 miles an hour. These extraordinary figures are especially interesting at the present moment, when projects are looming with the idea of applying electric traction to long railway lines. At any rate they put beyond doubt the fact that speeds of 80 or even 90 miles an hour are possible with good tracks laid without any great additional expense.

Leeds.—We understand that the work on the Roundhay Electric Tramway, which, it will be remembered, is to be run on the Thomson-Houston system, is being pushed on as rapidly as possible. The engine-room is now practically complete, with boilers and engine erected. The car bodies, manufactured by Messrs. John Stephenson and Son, of New York, have been received, and excite universal admiration. The poles for the wiring of the route are all set, and the objections heard have been trivial, the inhabitants rapidly coming to the conclusion that the overhead system is in some places convenient, and much better than nothing. The trucks, motors, and generators are daily expected, and probably will have reached England before these lines are in print. Fancy Leeds exchanging woollen stuffs for traction material from America!

The Liverpool Standard Frager Meter.—At the fortnightly meeting of the Lighting Committee of the Liverpool City Council, held on the 21st inst., at the Municipal Offices, the electric inspector, Mr. Yeaman, reported the completion of a series of tests undertaken with a view to the adoption of a standard meter with which to test the consumers' meters in use in that city. The tests included meters of the Hookham, Hartmann and Braun, Frager, Richard Frères, Laurence, Scott and Co., Aron, and Ferranti types, which have been standardised by various methods, including Thomson balances, Fleming's method, and Siemens dynamometers. The committee approved the adoption of the Frager meter as supplied by Mr. R. P. Wilson, Victoria-street, London, as a standard meter within the limits mentioned in Mr. Yeaman's report, and passed an order for the purchase of the instrument at a cost of £7. 10s.

Electrolytic Deposition of Ore. — The French Société des Ingenieurs Civils have lately had before them a discussion upon works supplied by power from the falls of Valloirette at Saint-Michel, Savoy, which is being established by M. Adolphe Minet. The Saint-Michel works will be specially arranged for the working on a large scale of M. Minet's electrolytic processes. The power at present at disposal is 6,000 h.p., of which

4,000 h.p. is capable of being utilised. This can be raised to 30,000 h.p. Besides aluminium, M. Adolphe Minet intends to carry out the electrical extraction of other metals and metalloids, particularly those elements of which the oxides are irreducible by carbon, and for which the processes of electrolysis by high-temperature fusion, of which M. Minet is the originator, is suitable. He intends to also develop the applications of electricity to chemistry and the refinement of metals.

Kidderminster.—At a meeting of the Kidderminster Town Council, on Wednesday, the Law Committee reported that the Act confirming the Kidderminster Electric Lighting Provisional Order having been passed, Messrs. Dyson and Co., the parliamentary agents employed by the Town Council, had sent in their bill of costs amounting to £201. 12s., which they recommended be paid. The town clerk having applied for some payment in respect of his services in this matter, as the conduct of parliamentary business was not contemplated as being among the duties to be performed for his salary, the committee recommended that he be allowed £20, in addition to his salary, for the work he had performed. The Mayor moved, and Mr. Harvey seconded, the adoption of the report. Mr. Holloway objected to this, and moved an amendment, but the motion was eventually carried. The principal items in the account were £106 for printing and £80 for parliamentary agents' fees.

Utilising Water Power in Devonshire.—Mr. Alfred Eccles, writing to the *Western Morning News* with reference to utilising water power, says: "Devonshire, with its abundant water power properly utilised, will need in the future to acknowledge not only no inferiority, but may claim absolute superiority to many coal-producing counties as a seat for manufacturing industries, free as it will be from all the drawbacks of smoke and dirt inseparable from the large use of steam and factory chimneys. I have often thought, indeed, that the true solution of many of our sanitary difficulties may be found in the transmission of electricity by wire to a distance, for use as power, light, and heat, so that it will be possible to settle our manufacturing populations in model towns, with ample space and modern sanitation, so reversing the present evil process of drawing labour from the country to the already over-populated towns, by carrying manufactures where labour can be carried on under the most healthful conditions."

Electric Tramways for Bradford. — Electrical engineers will be pleased to learn that Mr. Holroyd Smith, after achieving his success at Blackpool, is now in fair way of obtaining a fresh conquest for electric traction at his native town of Bradford. A trial has been agreed upon by the Municipality on the overhead system, on the Wakefield-road Tramway, and Mr. Holroyd Smith has undertaken to run an electric car for six weeks to prove the success of the system. The car will be provided at his own expense, whilst the current is to be obtained from the municipal central station. The Corporation will pay the expense if the experiment prove a success, otherwise they will only bear the loss of the current. If satisfactory, and the system is adopted, Mr. Holroyd Smith is to be appointed electrical engineer. The car is to carry 36 passengers, and will run on one of the Bradford Tramway Company's lines. His recent statement, received as a hyperbole, that he would equip a line at his own expense, is apparently to become a fact.

Factory Lighting.—Messrs. Dobson and Barlow, of Bolton, have for some time past had their factories lighted by 380 incandescent lamps. Recently, however, a new system has been introduced, which seems to be a modification of that occasionally used of throwing the arc light up on the whole ceiling, so that a diffused light is everywhere given. Alderman Dobson, a member of the firm, when in France, observed a system of lighting, the invention of MM. E. and P. Sée, of Lille, electrical engineers. Mr. Dobson has introduced this system into his works at Bolton, with, it appears, very satisfactory results. The lamp is an improved arc lamp with two negatives and two positives in contact, the light being thrown upwards by a large metal reflector to the whitewashed ceiling. The light is a soft brilliant white of wondrous diffusive power. The 380 incandescents are replaced by 26 of these lamps, giving 31,200 c.p. against 6,840 c.p. of the smaller globes. There is 15 per cent. loss in reflection; the arc lamps have no clockwork and require less current than the incandescent lamps.

Overhead Electric Tramcars for Walsall.—It was unanimously decided at a meeting of the directors and shareholders of the South Staffordshire Tramways Company, held on Thursday last week, at Darlaston, to adopt the overhead system of electric tramcars in place of the present steam traction for the towns of Walsall, Wednesbury, and Darlaston. It was further decided to authorise the creation and issue of £50,000 worth of debentures, bearing interest of 5 per cent., to carry out the system. It was explained that the electric traction would save at least 3d. per mile upon the present cost of working by steam. The local authorities have given their unanimous consent, and the contract will be commenced at once. A similar system is at work in several large centres in America, and it will be remembered that Mr. F. Brown, of Walsall, was recently commissioned to travel in the States and report upon the method of working. The electric tramway will be the second having overhead conductors in the United Kingdom, and will be the longest. The working both of this line at Walsall and that now almost ready at Leeds will be watched with the keenest interest.

Priority in Alternating-Current Motors.—The article which we reproduced on September 11th from our New York namesake, discussing the priority of discovery of the alternate-current motor, claimed this priority most emphatically for Mr. Nikola Tesla, who on October 7th, 1887, filed an application for patents in America, having already built and shown his machine in work and formed a company to exploit it some months before this. Mr. Tesla was run very close in claim for priority by Mr. Haselwander, whose machine, built in 1887, is now being shown at work at the Frankfort Exhibition. We have enquired of Messrs. Lahmeyer and Co., of Frankfort, who hold the Haselwander patents, as to the exact dates of the construction of this motor. They state that the first Haselwander rotary-current motor was constructed in the summer of 1887, and was set to work on October 12th, 1887. The first application for a patent for the said motor was made on the 21st July, 1888. As the patents were applied for by Tesla on October 12th, 1887, and were actually issued on May 1st, 1888, 17 days before the publication in England of Prof. Ferraris's Italian paper on "Alternating Motors," and two months and a half before the date of Haselwander's patent, this would seem to settle the question, at any rate with the present data before us, in favour of Mr. Tesla.

The Electro-Harmonic Society.—The first smoking concert of the Electro-Harmonic Society will take place on Friday, October 2, 1891, at the St. James's Hall Restaurant (Banquet-room), Regent-street, W., at 8 o'clock. Artistes: Mr. James Brown, Mr. Albert James, Mr. Arthur Thompson, Mr. R. Hilton; violin, Mr. T. E. Gatehouse; pianoforte, Mr. Alfred E. Izard; humorous selections, Mr. George Pritchard. Musical directors: Mr. T. E. Gatehouse and Mr. Alfred Izard. A Broadwood piano will be used. The programme will be as follows: Part I.—Glee, "By Celia's Arbour" (Horsley), Messrs. Brown, James, Thompson and Hilton; song, "By the Fountain" (S. Adams), Mr. Albert James; new song, "The Landlord's Daughter" (W. H. Jude), Mr. Robert Hilton; pianoforte solo, "Prelude and Fugue in E minor" (Mendelssohn), Op. 35, No. 1, Mr. Alfred E. Izard; glee, "Haste ye, soft Gales" (Martin); song, Mr. Arthur Thompson; humorous sketch, Mr. George Pritchard. Part II.—Duet (violin and piano), "Guillaume Tell" (De Beriot and Osborne), Messrs. Izard and Gatehouse; old French air, "I love but thee," Mr. Albert James; German song, "My lodging is the cellar here" (traditional), Mr. Robert Hilton; violin solo, "Potpourri of Scotch Melodies," Mr. T. E. Gatehouse; catch song, "Would you know my Celia's charms" (Webbe), Mr. Arthur Thompson; glee, "Mynheer van Dunck" (Bishop).

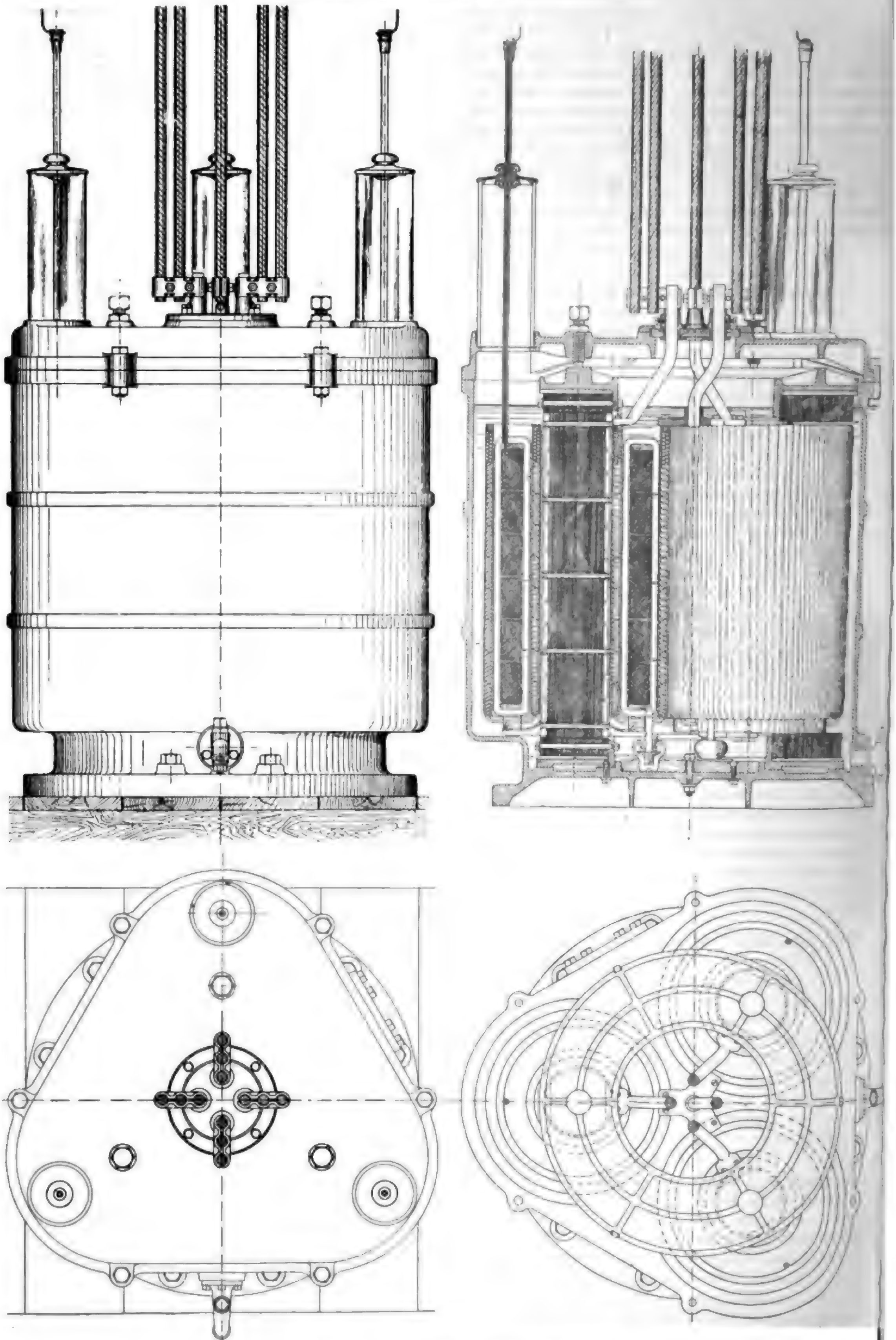
Montreal Exhibition.—An international electrical exhibition and a convention have just been held at Montreal. Sir Donald A. Smith, governor of the Hudson's Bay Company and M.P. for Montreal West, says the *Times*, opened the exhibition, the chief features of which were supplied by the Thomson-Houston and Edison Companies. Sir William Dawson, in welcoming the delegates, remarked that M'Gill University, of which he is principal, was about to come into possession of a fully-equipped department of electrical engineering, through the liberality of a prominent citizen of Montreal. Mr. Erastus Wiman was also among the speakers, and improved the occasion by commending such gatherings as likely to produce better relations between the Republic and the Dominion. He cited the notable fact that more telephones were used in Toronto and Montreal than in any other cities on the American continent. Apart from telephone and telegraph service, however, Canada was behind her neighbour. He referred especially to the rapidity with which electricity was superseding horse power on street tramways, one result being a marked increase in the values of real estate. At the ensuing convention, Mr. W. Hornsby, director of the electrical department of the Chicago World's Fair, said that it was proposed to hold a World's Electrical Congress in connection with the Fair. Such a congress, he urged, would do great good by leading to a revision of nomenclature, a unification of standards, and many other reforms.

Ransome-Sims Catalogue.—Amongst makers of steam engines for all and every purpose few makers have been more successful than Messrs. Ransomes, Sims, and Jefferies, Limited, of Ipswich, whose latest catalogue of engines is just issued. Their successes in exhibitions include 118 gold and 229 silver medals. Their factory, situated at Ipswich, now covers more than 12 acres of land, and employs over 1,400 men and boys. It can be reached in an hour and a half, and intending customers can often see their type of engine at work. Our readers being more particularly interested in electric light engines, we need only allude to the types of engine suitable for this purpose. A patent automatic governor expansion gear introduced for this type of engine has given excellent results. Various designs are made of portable and semi-portable engines, and for station work a special high-pressure steam engine on wrought-iron girder frame, and compound stationary engines with separate boilers fitted with the automatic expansion gear, 8 h.p. to 50 h.p., give great regularity of speed. Short-stroke and long-stroke stationary engines, with or without Corliss gear, are very fully illustrated in this catalogue, and boilers—Cornish, Lancashire, multitubular, or vertical—are specially treated. One type of engine lately introduced is a neat wall engine for situations where space is limited. It is fixed either inside or outside (with a pent-house) of a main wall, and can then easily be used to drive a dynamo either on the upper floor or upon a bracket, in this way saving the necessity for extra site. The catalogue is one which every electrical engineer should possess.

The Crystal Palace Station.—The Electric Installation and Maintenance Company for the supply of electricity to the Crystal Palace, Sydenham, and district was offered to the public in the third week in August, and the shares were then allotted. The work of installation was immediately proceeded with, and the progress made will, we think, rather astonish our readers. Immediately after allotment, Messrs. J. E. H. Gordon and Co., 11, Pall-mall, received the order to proceed with the works, and the construction was at once put in hand, and the whole of the electrical machinery will be ready for testing in a few days. The engines and boilers are promised for delivery in another three weeks' time, and the completing of the central station at Springfield is being pushed on day and night by relays of men. The laying of the mains from Springfield to the Crystal Palace will commence in a few days, and all will be completed in ample time for the opening of the electrical exhibition at the Crystal Palace on January 1st. The station at Springfield is to have a capacity of 20,000 lights, and the whole power of it will in the first instance be conveyed to the Crystal Palace, about a mile and a half distant, and will be supplied to exhibitors, either for lighting or power purposes, at the rate of 6d. per unit. A considerable proportion of the current available has already been applied for by intending exhibitors. At the close of the exhibition the power will be available to supply houses in Sydenham and district through distributing mains, which will meanwhile have been laid. The system of distribution is a direct current, at 1,000 volts, with motor transformers, which transform down to 100 volts.

Millbank-street Station. — The central electric station of the Westminster Electric Supply Company, at Millbank-street, which is situated close to the Houses of Parliament, adjoining the river, is about to have its present plant very largely increased, and in a few weeks the output will be nearly double its present figure. The machines now in use consist of four Goolden dynamos, driven direct by Willans engines. The output of each is about 400 amperes at 110 volts; the engines are of 100 h.p. Two of these dynamos are exclusively reserved for the Houses of Parliament. They charge a special set of accumulators, and have their own switchboard. These machines have been in use nearly a year and a half, and have worked perfectly. Opposite are two Edison-Hopkinson machines of the latest pattern, made by Messrs. Mather and Platt. These are larger than the Goolden machines, and are worked by similar Willans engines of 200 h.p. Two more machines of similar power will be added directly, but these will be Goolden machines. When these are added, all four will work in parallel with machines at Eccleston place on the three-wire system. They will work at about 220 volts pressure, giving 500 amperes. The present nightly output is about 1,100 amperes. There are three sets of accumulators, 56 in each set. One set is devoted to Houses of Parliament work, the other two to the general circuit. At present steam is supplied from three Babcock and Wilcox boilers, but two more will shortly be added to meet the increased demand. The pressure used is 150lb. per square inch; the accumulators are of the Crompton-Howell-type, with 33 plates each. Aron meters are used throughout the system.

THE LAUFFEN-FRANKFORT TRANSMISSION.



OERLIKON HIGH-PRESSURE TRANSFORMER.

THE LAUFFEN-FRANKFORT TRANSMISSION.

In our issue of Aug. 28 will be found a description, with illustrations, of the Oerlikon apparatus for the transmission of power, except so far as regards the transformers. We are now, by the courtesy of Mr. C. E. L. Brown, enabled to supplement the previous information with other details. In the first place, there seems to be in some quarters a difficulty in comprehending the winding of the armature adopted. This point may be made clearer by an examination of the accompanying diagrams. There are three distinct windings upon the armature, represented diagrammatically in the sketch, Fig. 1. The shaded rectangles represent the poles, those, say, at the right-hand side being alternately S and N. The three circuits are represented by differently formed lines. The method of joining the three wires is shown in Fig. 2, wherein three ends are shown joined together, while the other ends are open, to be connected with the transformers or with the line. The three circuits are shown as being 120deg. apart one from the other. This corresponds to the actual method of connection.

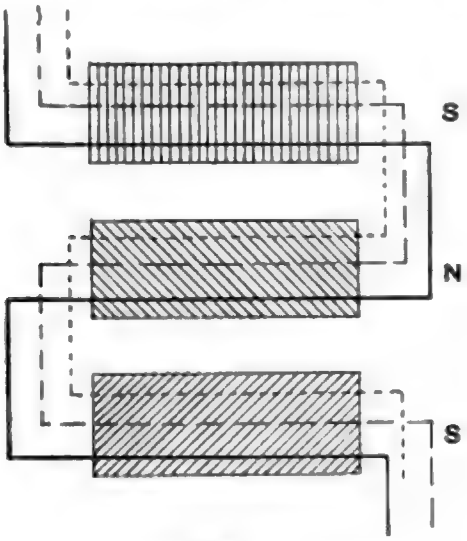


Fig. 1.

We further give on opposite page an illustration of the large high-pressure transformers employed in the Lauffen-Frankfort experiments.

The magnetic circuit is composed of three laminated iron columns of circular section, whose ends are connected by two flat laminated rings similar to a Brush armature core. Over each column are slipped the high and low tension coils. As the drawing clearly shows, the high-tension coil is boxed between the low-tension one. This disposition reduces the inductive drop, and simplifies the way of making the low-tension connections.

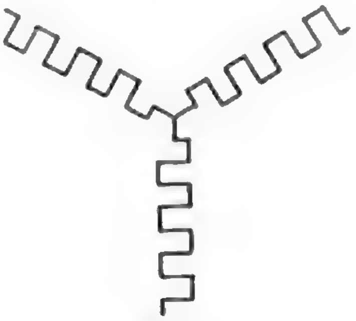


Fig. 2.

The construction of the whole transformer is such that any part of it can in a very short time be replaced. This transformer was designed to have an output of 200 kilowatts, and working with a normal pressure of 13 to 15 thousand volts. To ensure a very good insulation, the transformer is completely plunged in oil, but without this precaution the insulation is so good that the transformer can stand the high pressure of 15,000 volts, as has been proved by practical tests. The commercial efficiency at full load will be about 98 per cent,

In the early part of the year Mr. Brown read a paper at Frankfort on this subject, which appeared in the *Elektro technische Zeitschrift*, No. 11, an abstract of which we give elsewhere. It is somewhat generally thought that the multiphase current was the means of enabling the successful experiments at Frankfort. Mr. Brown says the multiphase current made the undertaking more difficult, as it involved many new complications in the dynamo, transformer, switchboards, and line. It was only chosen because of the possibility of driving self-starting motors without commutators.

ELECTRIC TRAVELLING CRANES.

The substitution of electric driving for other modes at present in use can be carried out upon any design of crane without necessitating important modifications. Excellent results are obtained, on the condition, of course, that the apparatus employed is carefully constructed and the arrangement is properly designed for the purpose required.

The application of electric motors to cranes has recently been carried out, says M. Desquieux, in the *Genie Civil*, by Messrs. Schneider et Cie. on several forms of their travelling cranes, notably upon a 60-ton crane used in their artillery works.

This crane was originally employed to serve a space of 50ft. wide and 330ft. long; worked by cables it could only raise 35 tons continuously with a speed of 2ft. per minute. With this load the speed of translation was 50ft. per minute. It was found that over 35 to 40 tons the rope slipped on all the pulleys and rapidly became charred. The life of the cable was hardly more than 10 months.

Recently the problem presented itself of making this crane serve 230ft. more, in all 560ft. The further use of cables could not be entertained, the inertia at starting being very considerably increased. It was necessary, therefore, to find other means of setting the gear in movement rapidly, and at the same time utilising the full power of the crane.

Very satisfactory results having been obtained with a travelling crane of 15 tons, it was finally decided to adopt as driving gear the electric motors of Ganz and Co., constructed at Creusot.

The following are the details of the arrangement: A Ganz continuous-current dynamo, type D 5, of 45,000 watts power, is fixed on the framework of the crane on the opposite side to the gearing, and drives the axle by a belt. The current is led from the dynamo by two bare cables of 12 mm. diameter, fastened at the two ends of the workshop and held up every 10 yards on porcelain pulleys; the current is taken off simply by two shoes fixed on the crane.

The accessory apparatus for starting and regulation, such as resistances, switches, ammeter, and voltmeter, are placed within the cage within the reach of the driver.

The current is produced by a dynamo, type D 5, of the same capacity as the motor. It also supplies current for a 15-ton crane carrying a D 3 motor, a wood-working shop which contains a D 3 motor, and several electric drills.

Under these conditions the crane raises with ease 40 tons with a speed of 7ft. per minute, and a load of 60 tons at 3ft. per minute. The speed of translation is about 90ft. per minute, so that to cross the entire space only requires about six minutes.

Owing to the method of exciting the dynamos, the voltage of transmission, which is 220 volts, remains constant, and the variations of speed of the motor empty and at full load do not exceed 5 per cent. Further than this no special precaution is taken for the running of the crane, and the maximum load is put on quickly without the least inconvenience.

Besides these advantages, the electric transmission has enabled an effective safety apparatus to be added to the crane gearing for the purpose of preventing any accidental fall of the chain in case of prolonged or involuntary descent. This apparatus breaks the main circuit to the crane, which at the moment of descent is always weak, while yet keeping the dynamo excited, with the result of a very quick stoppage.

This result could only be obtained by mechanical means at the expense of a considerable complication of gearing.

In view of the very excellent results obtained with this 60 ton travelling crane, Messrs. Schneider and Co. have decided to apply electric gearing to cranes of 10, 30, and 60 tons.

HEILMANN SYSTEM OF ELECTRIC TRACTION FOR RAILWAY TRAINS.

We have already urged the advantages of electric traction for tramway and underground railways with sufficient frequency for there to be any need to dwell further upon this side of the question. The smoothness of motion, the absence of vibration, the facility of starting, are all points which characterise this mode of traction. If, added to these advantages, economy and greater speed could be demonstrated, it would need no efforts on our part to draw attention to its extreme importance.

M. J. J. Heilmann has, as we have recently had occasion to mention, set himself the problem of applying this method of traction for ordinary long-distance railways without changing the present permanent way to any appreciable extent. The solution proposed by M. Heilmann, which is at the present moment in a fair way towards execution, consists in the daring scheme of carrying along with the train itself its own electric station—engines, boiler, and dynamo—and distributing the energy so generated to the various axles by means of directly-geared electric motors. The power for the train will be thus generated along the route, as is the case with the present locomotives, but with the additional benefits of speed, economy, and safety that can be obtained from the use of electrical means of traction.

The company formed by M. Heilmann in Paris, under the name of "Traction Électrique Système Heilmann," having offices at 30, rue de Grammont, proposes to carry out this project in two different manners, and the construction of one form of electric locomotive has already been commenced. This is formed of one long vehicle mounted upon two trucks, articulated together to form one locomotive, carrying boiler, steam engine, and generating dynamo, the current being transmitted by way of a switchboard to motors mounted on all the axles of this locomotive.

The second project is an extension of the first. It consists in furnishing the entire train with electric motors driving the axles of every waggon. As the details of the second project are yet being arranged, we shall speak more particularly of the first scheme.

It seems extraordinary, in the first place, that any advantage could be gained by transforming the mechanical energy of the locomotive into electrical energy and transforming this once more back again into mechanical energy, and at the same time increasing the weight of the train by the weight of the dynamos and motors. There does, however, exist such an advantage, and the reasons below serve to demonstrate this fact.

A railway line, although incomparably more perfect than an ordinary road as a track for locomotion, nevertheless preserves a great many of the defects of its prototype: it is sinuous, it presents differences of level, slopes and rises. It requires, therefore, on the part of the rolling-stock a large degree of adaptability and elasticity, without which both line and rolling-stock are subject to a rapid deterioration. Now this elasticity or suppleness is realisable for ordinary road carriages; the axles may be given the slight play necessary for turning the curves. Various efficacious arrangements may be provided to soften the effects of all inequalities of the road. With the locomotive this becomes, if not absolutely impossible, at least extremely difficult. This results from the reason that the axles of the locomotive are not only the supports of the carriage, they are also the crankshafts of a steam engine. To fulfil the first of these functions they should be capable of permitting all kinds of displacements; to fulfil the second they should, on the contrary, have their bearings in an absolutely fixed position. From these two opposite conditions a difficulty results which is evidently insurmountable. The proof of this may be seen in the multiplicity of axle arrangements which have been devised from time to time to realise each of these conditions without too far interfering with the other. The problem of the steam locomotive is not solved; the fault lies in its nature itself. We do not need to mention a further defect and one not less grave—the reciprocating nature of the movement. The latter yields effect not less disastrous eventually than the former, and the recent experiments carried out in America have shown the destructive influence of counter balance weights both upon the tyres themselves and upon the rails.

With the electric motor, nothing similar occurs; the movement is continuous and the energy constant. The motor is symmetrical around the axle and follows it in all its movements. Nothing prevents the possibility of allowing the necessary play between axle and bearing for describing the curves and the various displacements necessitated by the state of the road.

The electric motor allows the total adherence of the locomotive to be utilised, each axle being fitted with its own motor and exerting a tractive force.

The difficulty of getting rid of steam at very high speeds may also be mentioned.

The Heilmann electric locomotive presents externally the form of a car of 15 metres (49ft.) long, mounted upon two bogies of four wheels each. All the wheels are driving wheels. Their diameter is 1·04 metre (3ft. 5in.). All heavy parts rest, so to speak, above the bogie cars, so that the framework is relatively light. The boiler is placed behind and works the opposite way to those of the ordinary locomotive boilers. It is of the Lentz type, already applied with advantage to ordinary locomotives. Its chief features are a corrugated furnace, followed by a combustion chamber. The tubes are relatively short, and the boiler is without stay-pieces. The length it occupies upon the vehicle is about eight metres (26ft.). A free space follows for the stoker, then comes the steam engine, which is a high-speed machine coupled direct to the dynamo. Special arrangements have been provided for starting, stopping, reversing, etc., together with a special type of motor.

The front part of the Heilmann locomotive finishes in a conical point, to reduce the resistance of the air to a minimum. The driver will be seated within this projection, and will have before him all the apparatus and handles, both of the switches and of the brake.

Without entering further at the present moment into the details of the subject of this interesting system of traction, we may add only that it permits the attainment of any speed, however high, that can be borne by the rails, with trains of unlimited tonnage. The inventor states his confidence in being able easily to achieve the speed of 130 kilometres, or 80 miles an hour. The experiments which are shortly to be undertaken on the lines of the French State Railway, will inform us whether these expectations are capable of being realised.

HIGH-TENSION CURRENTS: THEIR PRODUCTION, CONDUCTION, AND APPLICATION.*

It is unnecessary in the course of this paper to go into the theoretical reasons why a given amount of electrical energy can be transmitted by thinner conductors, and with less loss, in proportion to the increase in the tension of the current. The simplest calculation shows that if we were not bound down within practical limits as regards the highness of the tension, immense effective energy could be transmitted by quite thin conductors with insignificant loss and to the greatest distances. But in this field, as in others, there are practical limits which cannot be exceeded. These limits are determined by the following points: Firstly, what is the highest tension which can be produced for industrial purposes by safe apparatus; secondly, what is the highest tension which can be transmitted over long distances with the means at disposal; and thirdly, to what extent can protective measures be adopted against the dangerous effects of a high-tension current.

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* Abstract of a paper read by Mr. C. E. L. Brown before the Electrical Society of Frankfort-on-the-Maine on 9th February, 1891.

Up to the present, currents of 2,000, 3,000 and perhaps 4,000 volts were considered the highest in practical use. However, the author's activity in the field of the electrical transmission of power and the ever-increasing scope of new projects, the carrying out of which would cause a great advantage in national economy, showed that the extreme limits of practicability had by no means been reached. The author has consequently endeavoured for several years past to introduce higher-tension currents for practical purposes, and the question has arisen as to the best means of producing them.

In considering closely the subject of our ordinary continuous-current dynamos, the limits of practical possibility is soon reached. The arrangement of the armature winding and the necessity of a commutator render it difficult to construct machines for high tension, at least with the insulating materials available up till now. The author has constructed continuous-current dynamos up to 2,000 and 2,500 volts, which could be run uninterruptedly day and night without causing difficulties. The construction of these, however, showed the author that if higher tension currents were not impossible, yet they led to circumstances, and particularly between the insulating material and the working copper of the armature, which would cause the machines to reach an uneconomical size.

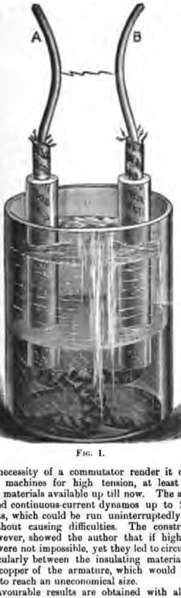

Fig. 1.

More favourable results are obtained with alternating-current dynamos which deliver a high-tension current direct. The separate and complete divisions of the armature winding, each of which produces only a fraction of the total current, the dispensing of the commutator, and the possibility of allowing the armature to stand still and to rotate the magnetic field, render the alternating-current machine essentially more suitable for the direct production of high-tension currents. An excellent example of this is to be found up to the present in the large Ferranti dynamos.

But however well constructed, all dynamos for the direct production of high-tension currents have the disadvantage that they require manipulation while running, thus not quite avoiding a certain danger of interruption and to the workmen. The ideal apparatus for our purpose is one which is not in motion, which does not require continual attention, and which will perhaps work without interruption for years, and without having to be touched outwardly. We thus come to the transformer. The object and manner of working of the transformer are well known, and the author therefore gives the points which have guided him in the construction of his transformers. A transformer should be so made that it can readily be taken to pieces. The primary and secondary coils should be independent, and both easily removable from the mass of iron and from each other. The construction of the coils should be of such a nature that they can be made without special expert labour on any lathe, as faultless work at the beginning gives the best results, and allows of repairs being easily effected. The insulation should be such that an arc, or contact between the two windings, may be regarded as impossible. Lastly, the general arrangement and the external protection should allow of the apparatus being fixed without danger in any place and under any circumstances. That the construction of a transformer which will fulfil all these conditions is possible is shown by those made by the Oerlikon Engineering Works. There is now, of course, the usual transformer for pressures of 2,000 to 3,000 volts, but none of that kind for tensions of 20,000, 30,000, and 40,000 volts. But if it is possible to make one to work after the ordinary type for very high tensions fresh from the workshop, its working safety would be interrupted, first of all, in consequence of the influence of the atmosphere, out of which all usual insulating materials absorb more or less water. Against this a new factor must arise—namely, oil as the insulating material. Oil is one of the most perfect non-conductors, and the high insulating properties of a thick resinous oil can be shown by a simple experiment. The ends of two cotton-covered wires are twisted together, and placed in a vessel containing oil, see Fig. 1. This is then heated highly for a long time, so as to expel all the water from the cotton and from the oil. Glass tubes are placed over the wires where they project from the oil, and the tubes reach below the surface of the oil. Water can then be poured upon the oil. On connecting the upper free ends of the wires with, for instance, the poles of an influence machine, sparks several centimetres in length can be obtained between the wires in the air without any arc being formed between the twisted parts of the wire immersed in the oil. This is certainly a striking proof of the insulation attainable, and of the resistance to the formation of an arc, afforded by the use of oil.

The first use of oil in this way was probably by Brooks, in connection with underground conductors. The author was the first to introduce oil as an insulating means for high-tension transformers. He places, first of all, the whole apparatus in a cast-iron box, which is then filled with oil, and subjected for a long time to a temperature of up to and over 150deg. C. The advantages of this are—the oil forces its way into all pores and crevices of the apparatus, expelling all air and moisture, and covering the whole transformer. By this means the possibility of the piercing of the insulation is greatly minimised, and the transformer is absolutely protected against the external influences of the weather, dust, etc. These influences affect only the upper surface of the oil filling, and the oil always remains a compact mass, and is thus preferable to paraffin, for instance, which in time cracks and absorbs moisture. Great care is, in addition, necessary in the winding of the coils with the thin wire, and in the insulation of each layer from one another. Special attention must also be devoted to the manufacture of the leading-out wires. For low-tension currents the coils are usually extremely simple. The first of the transformers made on the lines pointed out by the author, could at once be worked up to 40,000 volts without causing any difficulty.

By means of transformers exceptionally high-tension currents can be produced without any difficulty. The next question is the generating station for a large installation. The generator will be an alternating-current dynamo of as low tension as possible. The winding of the armatures of the dynamos used in the Oerlikon Works installation consists of copper bars, 30 millimetres thick, which are insulated by merely being placed in paper tubes. It is, perhaps, surprising that the winding of a dynamo can consist of such thick, massive copper bars, but their use is even possible if the bars rest in closed holes in the armature iron. This method, it will be remembered, was already employed by the author in 1885, in his ordinary continuous-current dynamos. Such machines, with a tension of about 40 volts, are absolutely safe. The current from a dynamo of this type is then converted by means of an oil-filled transformer into a high-tension current. As regards the measuring and safety appliances at the station, all switching and measuring can be done with the low-tension current, by which no greater danger is incurred than obtains with ordinary continuous low-tension current installations. At the most, for the control of the high-tension current a static voltmeter may be employed, and which does not require to be touched. To prevent short-circuitings, leaden cut-outs are placed in either the high-tension or low-pressure leads.

For the transmission of the current over long distances and open country overhead conductors are required. There is much prejudice against this, but time and experience will overcome it. As regards insulating the wires at the places of support, the ordinary double-bell telegraph wire insulators are fairly efficient in a dry atmosphere, but are unsatisfactory when there is moisture. Here oil is again required, and for this purpose the well-known Johnson and Phillips fluid insulators, which the author describes, first originated. The insulating properties of these simple insulators is exceptionally high. Prof. H. F. Weber, of Zurich, made experiments in the autumn of 1887 with those insulators which had been in use for a year and a half on the Kriegstetten-Solothurn line. The total length of wire is 15 miles, and with a current of about 2,000 volts pressure not the slightest loss due to the insulation could be detected. The insulation of the conductors was absolutely perfect. However, for currents of 10 times the voltage in question, more is desirable. The most simple way of increasing the insulating effect is to use two of the fluid insulators to support a third, and other methods have been devised by the author. These fluid insulators require from time to time to be inspected, cleaned, and refilled with oil. This is not a disadvantage, but is, on the contrary, a recommendation. It necessitates an involuntary control of the fastening of the wires to the insulators, of the poles, and of other protective arrangements, which might otherwise be neglected.

Having now got a satisfactory solution of the question of the insulators, the next point is the poles. Wooden poles will be most often employed, and as it is desirable to have as few as possible, they must be strong and placed at distances of from 230ft. to 330ft. apart. If iron poles are used, the distance can be increased to 660ft., but a correspondingly stronger conductor will be required. Under all circumstances, the poles must be as high as possible, and the conductors carried above everything, including telephone and telegraph wires. Where the conductors pass over streets or railways, a protective net or wires are needed between the poles so as to catch the conductor in case of breakage. These protective arrangements must have a good earth connection. Where the conductors cross others, it is advisable to attach them all to a pole.

Protection against lightning must be provided. This safeguard must not only be provided at each end of the conductors, but also at intervals along the line. The distance apart which the lightning conductors should be cannot be accurately determined as yet, and must be found out by experiment and by experience.

A question about which little definite can be asserted is the loss of current through the atmosphere. Whether this plays a part at certain tensions over long distances we shall perhaps discover some months hence. In any case, the danger of any appreciable loss in this manner is much less than has hitherto been believed in technical circles.

Coming now to the question of the utilisation of the current which has been generated and conducted, it will be found generally that it will not be reconverted into mechanical power alone. As a rule, it will probably be employed for various purposes in connection with the driving of motors, for electric lighting and otherwise. In any case the high-tension current will not be used direct. In most cases the current will be transformed downwards not only once, but twice. For instance, a current of 30,000 volts will be converted at transformer stations, which will be equivalent to central stations, to 1,000 or 2,000 volts and then distributed to the consumers or to sub-transformer stations.

The whole arrangement from the generating station to the place where the current is utilised may appear at first sight to be roundabout and uneconomical, but closer inspection shows a totally opposite result. As regards the generating station the dynamos for low-tension currents can be made considerably cheaper than those for high-tension currents, so that there are only the transformers to be taken into consideration. The efficiency of low-pressure dynamos is also higher than that of high-tension machines, so that the difference of the combination of dynamo and transformer only comes to from 1 to 2 per cent. at the utmost. By the employment of high-tension currents for the transmission, the amount of material for conductors and the great reduction in the loss in the same, more than counterbalance the extra cost of the transformers and the loss in the transformation. The following is a simple example of this: In the case of transmitting 500 h.p. over a distance of about 12½ miles, the currents can be generated at an E.M.F. of 5,000 volts with a loss of 10 per cent. in the conductors, whilst in another case it can be converted to 30,000 volts by means of transformers and carried at a loss in conductors of only 3 per cent. In the first plan conductors of about 90 square millimetres section would be required, and in the second of only nine square millimetres. In the former the weight of copper would be 32 tons roughly, and in the latter only 3·2 tons. The copper required is thus only one-tenth, although the tension of 5,000 volts already represents a fairly high pressure. By means of such economy in the material of the conductors, the very large increased cost in the transformers would be counterbalanced. Taking the subject from the point of view of efficiency, the following results are obtained: The efficiency of a 500-h.p. machine at 5,000 volts will be at most 92 per cent. Allowing for a loss of 10 per cent. in the conductors, the efficiency at the other end of the line is about 83 per cent. In the second case the efficiency of the primary dynamo and transformer is 90 per cent., the efficiency of the conductors 97 per cent., and the same in that of the secondary transformers. The ultimate efficiency is thus 84 per cent. In the latter instance the 84 per cent is available at a handy E.M.F., while in the former the tension is about 4,500 volts, which, under certain circumstances, is very inconvenient, and has consequently to be transformed. It is evident, therefore, that the second plan, notwithstanding the double conversion, is the more economical.

The idea of transforming low-tension currents into high ones at one end, and re-transforming them into low-tension currents at the other, is not a new one. The author drew up a project on these lines, at the commencement of 1886, for the town of Naples, where he proposed to transmit current at 10,000 volts. Nothing, however, was done in the matter.

In view of the Lauffen-Frankfort transmission scheme, the author made some preliminary tests. He employed two small transformers of about 5,000 watts for a tension of about 30,000 volts. These were connected together by a copper conductor, carried on more than 100 fluid insulators, and in the secondary current of the second a corresponding number of glow lamps were inserted. The primary current was supplied by a small alternating-current dynamo at 100 volts, which was driven by an electro-motor. This installation has been running almost daily since the middle of November, and partly under most unfavourable conditions of weather, at tensions up to 40,000 volts. There were no abnormal appearances during this period, either in the transformers or in the conductors.

The transmission of electric power by means of currents of, for instance, 30,000 volts will enable its distribution over very great distances, and enable sources of power at present lying idle to be utilised to the advantage of industry. The carrying out of such installations is quite practicable, but there is still much to learn and to improve.

PUBLIC LIGHTING IN EASTERN EUROPE.

The French Government having desired its consuls in the principal towns of the East of Europe to report on the public lighting of those places, the representatives of France have furnished particulars on that subject, which are published in the *Moniteur Officiel du Commerce* for July 9 and 16. According to these reports it appears that there exists no manufactory of lighting apparatus in Roumania, with the exception of one recently founded in Bucharest, and this at present does no more than produce wickholders for petroleum lamps; the cylindrical glasses for the same are principally made at the glass works of Azuga. It is intended to make lamps in the Bucharest factory, and before very long it is probable that the whole apparatus for lighting with petroleum will be manufactured at least at one place in Roumania. With the exception of certain small accessories, everything connected with lighting by means of gas has to be imported into Roumania from abroad. Most of the lamps now used in that country are furnished by makers in Austria-Hungary, mainly from Vienna and from Buda-Pesth. Lamps are also imported, but in much smaller quantities, from Germany.

There is no gas used in any town of Roumania except Bucharest. Everywhere else simple petroleum lamps are used, and the town of Galatz is lighted by 1,695 of these. At Jassy the theatre and the circus have lamps of vegetable oil, but everywhere else petroleum only is used in glass lamps with a straight wick. For domestic lighting, lamps of all dimensions are used, with burners and circular wicks, all of which lamps are imported from Austria or Germany.

When we turn to Servia, we find that Belgrade, the capital, contains no manufacturer of illuminating apparatus. The streets are lighted by a few petroleum lamps with reflectors, and when the municipality has need of a supply of lanterns it applies to the Jewish tinmen, who produce what is required. Nisch is lighted only by petroleum lamps at certain important points of the town, and there is not even a shop devoted to lighting or lamps; the latter are ordered from Vienna or Buda-Pesth, and sold by grocers or dealers in hardware.

In Sofia, the capital of Bulgaria, there are several dealers in lighting apparatus, but there is no manufacturer of these articles in any part of Bulgaria. What is used comes exclusively from abroad, and principally from Bohemia. There is a small importation of glass lamps from Belgium. No other substance than petroleum is used in any part of the country. Lighting apparatus only figures in the Bulgarian trade reports under the head of "Glass manufactures." The figures of the import value of these articles, in 1889, was £5,400. In Varna, as in Sofia, petroleum alone is used for lighting. The favourite form of lamp is a cheap suspended lamp, with a single burner. There is a great sale at Varna of small lamps, specially introduced for the little towns and villages of the interior. These are made of glass, and cost about 18s. a hundred.

In European Turkey little is used except petroleum. Even in the public offices of Constantinople, into which gas had been introduced, it has been found so bad and so expensive that it has for the greater part been rejected, and petroleum once more taken into use. In private houses, as in shops, cafés, and restaurants, nothing is now used but the large petroleum lamps. The electric light is employed only in the palace of Yildiz, it being forbidden by law to use it elsewhere. The supply of lamps for Constantinople is almost entirely in the hands of Austrian and German merchants. The kinds which they supply are usually of second-rate or even inferior quality, cheapness being an essential matter. The natives are in the habit of calling petroleum gas, even when they are speaking French, but it is important to understand that they always mean petroleum. There are three French shops in Pera, and an Austrian house in Stamboul, where lamps of a better quality may be bought.

At Adrianople no gas is manufactured, and an attempt which was lately made to illuminate the city with the electric light was a complete failure. The only material used is petroleum, which is imported from the Russian establishments at Batoum. The city is lighted by very cheap lamps on a most imperfect system, consisting merely of a cylindrical box of tin-plate, scarcely eight centimetres high, and priced at from 8d. to 9d. each. The inside of certain establishments, such as cafés and hotels, is lighted by lamps of a more elaborate description, from Austria or Germany. Austria inundates the country with a cheap article, devoid of all solidity of construction, but sufficient to satisfy the requirements of the Turks.

The only product employed for lighting purposes in the island of Crete, except candles, is Russian petroleum oil of very bad quality, and dispersing a disgusting odour. The lamps are generally very common, but cheap. Most of them possess a glass reservoir mounted on a stand in porcelain or metal. These are imported from Austria. No manufacturer of lighting apparatus exists in Eastern Roumelia. Petroleum lamps are used, and these can only be purchased in the capital, Philippopolis. At Bourgas, the chief port of Roumelia, all lighting apparatus has to be brought from Constantinople.

Oil is but very little used for lighting in Salonica, and, consequently, there is no sale for articles intended for this species of illumination. Gas works have recently been set up in Salonica, but hitherto the number of consumers is very small. Petroleum is almost exclusively used throughout the town, and there is a considerable market for apparatus used in this kind of lighting—portable lamps of all sorts, with glass, porcelain, etc. All these articles are of Austrian manufacture, and of inferior quality, but find a ready sale, on account of their cheapness. A Paris house attempted, some time ago, to introduce in Salonica lamps of its manufacture, but they were not bought, as they were too expensive. A manufacturer who wishes to sell his lamps in this town ought first of all to obtain information as to the price at which similar articles are at present sold there. The only form of illumination which is employed in Albania is petroleum lamps, the importation of which reaches a value of £500 or £600 a year. None are manufactured in the country—even at Janina, Scutari, or Durazzo, but are manufactured in Austria and introduced from Trieste to ports along the Albanian coast, and sold in the bazaars. In Bosnia-Herzegovina, also, gas and oil are totally unknown as illuminants, and the whole country depends on the importation of cheap petroleum lamps from Austria.

In Greece gas is used in the towns of Athens and Corfu. In the former everything connected with lighting by gas is supplied by a French company on the spot; in Corfu the apparatus has to be imported from an English gas company at Malta. In the rest of the country lighting is almost exclusively performed by means of petroleum lamps of Austrian or German munufacture. At Syra there exists no person who regularly sells lighting apparatus of any description, but very bad porcelain or metal lamps may sometimes be picked up at the china or tin shops. There was once a proposal that Syra should be lighted with the electric light, but the poverty of the municipality and political reasons combined to prevent it.

Mr. T. B. Sandwith, her Majesty's consul-general at Odessa, writing to the Foreign Office, under date of 1st August, says that the port of Odessa, in contradistinction to the town of that name, having, for many years, remained unlit, even by oil lamps, and, within two years only, being lit by gas, has at length been illuminated by electricty. An installation has been completed, at a cost of 80,000 roubles (£8,400). This consists of 64 arc lamps, of 2,000 c.p. each, and of two lanterns, one at each end of the breakwater, which runs the whole length of the port. The illuminating power is generated by two of Wilson's vertical engines, of 67 h.p. each.

The Odessa Town Council has just assigned a sum of 20,000 roubles (£2,100) annually for the working expenses.

The new installation is a great boon to the shipping interest, the whole of the port being brilliantly lighted up, so as to admit of the loading and discharging of steamers by night.—*Board of Trade Journal.*

THE
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We may occasionally follow the lead of our American Contemporaries, especially when they point out a serviceable way. They are not backward in asking their friends to do all they can for the welfare of the paper. We ask our friends to remember us. No Paper that we know ever refuses Subscribers or Advertisers. Nor do we; in fact, we invite them, believing that they will get full value for their money.

Specimen copies of the paper will be sent on request.

WILLIAM STURGEON.

Prof. S. P. Thompson is indefatigable in tracing out the history of electrical science, and in the attempt to give due credit to those who have added to our knowledge of the subject. He is enamoured of the work and position of William Sturgeon, and, it may be remembered by those present, made some very complimentary remarks as to Sturgeon's position in the history of the subject at the Society of Arts during his last Cantor lectures. Within the last few days Prof. Thompson has issued a small pamphlet—for private circulation only—entitled " William Sturgeon, the Electrician ; a Biographical Note by S. P. T." This pamphlet has accidently come into our hands—not from the author, therefore we dare his anger in publicly attending to the matter. However, after all, Prof. Thompson desires publicity in that one of the objects he has at heart in connection with Sturgeon is to find the whereabouts of "a portrait of Sturgeon, a fine oil painting, which was formerly in the possession of his adopted daughter, Mrs. Brierley." This portrait "is believed still to exist," but where is a question not easily answered. At any rate, Prof. Thompson has as yet been unable to find it. This search, as many another, has come a little late. Mrs. Brierley, according to the tombstone in Prestwich churchyard, died on January 19, 1884—not so many years since. Surely, then, given due publicity, there must be still living many friends of Mrs. Brierley who, visiting at her house, would remember if in her later years the portrait was in the house. The pamphlet does not tell us if Luke Brierley, the husband, died before or after his wife, or is still alive. If dead there should be some near relations who could tell how the furniture was dispersed, and one of whom may have possession of the much-looked-for portrait. It may perhaps be regarded as a bit of sentimentalism to trouble about the looks of a dead and gone electrician, but surely in a sense such a man as Sturgeon has done more good for mankind at large than some of the political men whose names are recorded in every child's history and whose portraits hang in the galleries of the homes of their descendants. The Marquis of Worcester might have been an idiot according to the views of his contemporaries for experimenting with steam, but those who developed the use of steam as a motive power have done more for their kind than the whole race of monarchs of any kingdom. If, then, Sturgeon was the discoverer of the electromagnet, he discovered a piece of apparatus that bids fair to create as great a revolution as did the discoverer of the capabilities of steam. A glance at Sturgeon's published utterances shows how vast a progress has been made since his time, and should rather tend to modify the arrant conceit of those who do not hesitate to assert, practically, the infallibility of the authorities they worship or claim to be. Sturgeon, in 1843, says, " Various means have been resorted to for measuring the relative degrees of galvanic force ; but as every attempt has failed, I have introduced," etc. We trust that Prof. Thompson's action will be the means of unearthing the lost portrait. It might be as well if those willing to make enquiries were told what has already been done. Has anything been found out about Luke Brierley or his family, or about the family of Ellen Coates (Mrs. Brierley)? Knowing what has been done might save someone the trouble of going over the same ground again.

Might we also suggest at this time of credit-giving that Dr. P. M. Roget, the secretary of the Royal Society in the early thirties, has not received the amount of honour due to him for his then excellent treatise on electricity, galvanism, magnetism, and electromagnetism. On p. 54 of "Electromagnetism" is an illustration and description of "a very powerful temporary magnet" (an electromagnet), but no reference to Sturgeon in connection therewith, though credit is given in other things to Sturgeon. The experiments of Prof. Mott are referred to on the same page, and these are described by Sturgeon in his "Researches," as is duly noted in Prof. Thompson's new work on "The Electromagnet."

TELEPHONY.

The discussion on telephony in London has been continued in the *Times*. Mr. F. Faithfull Begg, in a letter dated Sept. 16, offers some criticisms, but no information. Mr. Wallace, in one dated Sept. 17, does the same, and only one or two sentences of his letter need be referred to. He says: "No system will be adopted (that is, by the new company) until it has secured the approval of a commission of technical experts. To them will be submitted Mr. Bennett's and any other system worthy of consideration." We should like to ask, Where are the men to form a commission of experts to sit upon suggestions of such men as Mr. Bennett, the Government officials, Mr. W. H. Preece, Mr. Heaviside, and Mr. Gavey? Why, there are no experts who can hold a candle to these men, any one of whom has more knowledge of the subject than any dozen men in the country, excepting perhaps one or two of the National Company's officials. Messrs. Preece, Heaviside, and Gavey are Government officials, and certainly will not be permitted to sit on a commission and give the result of their experience to further the plans of a private company. There are one or two men who have been, but are not now, connected with the National Company who are keen-sighted enough to know what is better than the system of the National, but no single person, except Mr. Bennett, as yet has contributed to this discussion who may, by the greatest stretch of the imagination, be termed a telephonic expert. It may be that these experts are to be brought from the Continent or from America, though what they can know about the peculiarities of English working remains to be seen. The Duke of Marlborough, with whom we understand Mr. Wallace is working in this matter, somewhat possibly to the surprise of his colleague, sketches out the plans it is proposed to adopt. His letter appears in the *Times* of Wednesday last, and is reprinted elsewhere. The Duke of Marlborough, however, falls into error in estimating the difficulties of good telephony at too low an estimate, and he will find when he comes to actual work that something besides twin wires is required to ensure satisfaction to his customers. Let him ask Mr. Fletcher, of the National, where his troubles begin and where they end, and if they would be ended by twin wires. We fancy Mr. Fletcher in reply would smile, and shake his head. There are other points in the Duke of Marlborough's letter to which exception might be taken; and if we might presume to advise, it would be that the financiers of the new undertaking, having obtained that cheap advertisement for their plans this discussion was intended to obtain, would retire into the background, carry on the work nature has given them talents for, and employ the best men available for organising the system to be adopted on the twin-wire plan. It was perhaps necessary for those who intended to float a company, and ask the public for money, to take the course that has been taken, but they will only damage themselves by entering into technical details they evidently are only slightly familiar with.

WONDERFUL.

Really, the writers in the daily papers must imagine electrical engineers as partaking of the nature of gnomes, burrowing underneath the surface of the earth and working in the dark. According to the reasoning of the *Globe* we require an invention for every application of electricity. We thought that something had long ago been done towards adapting the electric light to picture galleries, but it seems that it is not so, for quite recently a young firm "registered a design of this nature (expressly for the illuminating of pictures), and already they have commissions to fit a couple of galleries with their patent reflector." We are glad to hear of this success, and might suggest the registration of a design for a reflector to illumine the various public clocks, and no doubt the act of registration would bring further orders. By the bye, is the registration of a design the same as taking a patent? Our contemporary evidently thinks so. We are further informed that "if the enterprise be successful, it may not be very long before the National Gallery becomes an agreeable, cool, and entertaining evening resort." There has been no time within the past ten years when the National or any other picture gallery could not have been successfully lighted electrically. It is nearly that time ago since we saw at least one private gallery so lighted, and we understand the light has been used continuously since it was installed without a failure. We should hardly like to hint that the lighting of such galleries electrically depended upon the designing of a reflector. There certainly has been no delay through lack of reflectors: the delay has been caused more from lack of money or inclination. It is very easy, also, to suggest the lighting of this and of that public building; but other considerations than the possibilities of such lighting have to be taken into account. There is the initial expenditure, the maintenance of the light, an extra expenditure in all directions from having the buildings open through longer hours. If the *Globe* will do its best to educate the Treasury and the House of Commons up to the point necessary to permit this extra expenditure, the electrical engineer will not be found lacking in suitable apparatus. So far as lighting is concerned, and to a great extent so far as the transmission of power is concerned, the only deficiency in carrying out any idea is money.

LITERATURE.

The Elements of Dynamic Electricity and Magnetism. By PHILIP ATKINSON, A.M. Crosby, Lockwood and Son.

That part of the year which is usually called winter is approaching, though, perhaps, the climatic conditions may not materially differ from those persisting during the period called summer. However, the coming time is devoted more to books than the immediate past, and it will be necessary to refer to the accumulation upon our table. Dr. Atkinson has compiled a very readable manual of the usual pattern. He discourses in a simple way of the prominent phenomena and apparatus pertaining to the subject, and may be acknowledged to have fairly met the scheme design—viz., a book "for learners rather than for the learned" It is perhaps lucky that Edison had not uttered his doubts of Ohm's law and mathematical conclusions before this work was written, or the author would have waited for the new Edisonian electrical manual that will save a world of labour and put us all right. Still, with all who stand afar off and admire authorities, this book will be welcome, as being clear in style, amply illustrated, and altogether according to "Cocker." One statement will be read with some astonishment, coming from America—viz., the crediting of Hughes (and we deem correctly) with the invention of the microphone. Dr. Atkinson must be commended for such boldness. Altogether the book is very readable and just what the general reader wants.

An Introduction to the Mathematical Theory of Electricity and Magnetism. By W. T. A. EMTAGE, M.A. Clarendon Press, Oxford.

This book is written purely from the scholastic point of view, and as such must be judged. It is hard to realise wherein the practical value of such a book lies. The examiner has to set questions, the student has to answer them in order to pass examinations. That is the fad of the era. When the student has satisfactorily answered the questions he is a learned man, though if a dynamo was sparking he might be unable to adjust the brushes. The aim of this class of book and the system it represents is to make the subject as difficult to the student as possible, and at the end of his student career to leave him with as little real knowledge as possible. Our American brothers, in their dry matter-of-fact way, laugh at the system in their little jokes. Thus, an intellectual-looking man, in goggles, happens to be in the country, and being of an enquiring mind, asks the man in the field a lot of questions. What is growing in that field? Turnips. And in that? Corn. Dear me! What is that animal? Oh! that's a cow; and so on. In the end the man in the field enquires the profession of the questioner, and hears that he is the editor of an agricultural paper, and has been editor for 20 years. But we must be thankful for small mercies, and thank Providence that Oxford and Cambridge men have not yet put out brass plates or sounded brazen trumpets to proclaim that they practise as "consulting engineers." Having said thus much against a system, and expressed inability to agree with Pope, that "whatever is is right," we are bound to admit that, accepting the situation as it stands, the book before us is one of the best ever issued in the interests of that system. Given the necessary mathematical knowledge, the student is here presented with an excellent epitome of the subject. To point the moral of our story, take as an example the last paragraph in the book, relating to that most interesting topic of the hour—the transmission of power:

"13. *Transmission of Power.*—Sometimes a dynamo is used at one station, where there is a source of energy; to develop a current and drive a motor at a distant station, where work is required to be done; by means of conducting wires between the two stations. This operation is generally called the 'transmission of power.'

"Suppose we have a series dynamo and series motor.

"Let E be the E.M.F. developed by the dynamo.

"E′ the back E.M.F. developed by the motor.

"R the entire resistance of the circuit formed of dynamos, motor, and conductors.

"I the current passing.

"The electrical energy developed per second is

$$E\,I = \frac{E\,(E - E')}{R}.$$

"The work done per second by the motor is

$$E'\,I = \frac{E'\,(E - E')}{R}.$$

"The work lost in heating conductors is

$$R\,I^2 = \frac{(E - E')^2}{R}.$$

"The intrinsic efficiency of the arrangement is

$$\frac{E'}{E}.$$

"Suppose we increase E and E′, keeping E – E′ constant. Then the energy lost in heating conductors remains the same as before; but both the efficiency, E′/E, and the activity $(E - E')^2/R$, are increased.

"Thus it is advantageous to run at high E.M.F.'s." This is all very pretty, but the student should consult a text-book to find out, say, the loss in the motor, the loss in the leads, the loss in the generator, and so on. He wants to know the power he must put into the motor to get a horse-power on the shaft of the motor; more, he wants to know the power he must put into the shaft of the generator in order to get under the given conditions a horse-power delivered at the shaft of the motor. What, again, we ask, is the practical value of a book professing to treat the subject in an advanced manner, that leaves us in ignorance of such questions? and we doubt if the most gifted reader would get more practical knowledge from this and similar works, than he would from a pocket-book crammed with formulæ. In fact, all the examination system provides us with in the way of books is of the character of a more or less elaborate way of developing formulæ.

The Arithmetic of Electricity—A Manual of Electrical Calculations by Arithmetical Methods. By T. O'CONOR SLOANE, PH.D. New York: Henley and Co. London: E. and F. N. Spon.

The title of this book pretty well explains it purport. The method is to state a rule and then work out an example. Thus 74 rules are given dealing with practical requirements. An example will be the best means of showing the value of the book. On page 96 is given:

"Rule 71.—One volt E.M.F. is generated by the cutting of 10^8 (100,000,000) lines of force per second.

"*Example.*—A single convolution of wire is bent into the form of a rectangle 7 × 14 inches. It revolves 25 times a second in a field of 20,000 lines per square inch. What E.M.F. will it develop at its terminals?

"Solution: The area of the rectangle is $7 \times 14 = 98$ square inches. Multiplying this by the lines of force in a square inch, we have $98 \times 20{,}000 = 1{,}960{,}000$. Each side of the rectangle cuts these lines twice in a revolution, and makes 25 revolutions in a second. This gives $25 \times 2 \times 1{,}960{,}000 = 98{,}000{,}000$ lines cut per second, corresponding to $98 \times 10^6 \times 10^{-8} = 98 \times 10^{-2} = \frac{98}{100}$ volts E.M.F. generated, as $\frac{98000000}{100000000} = \frac{98}{100}$ volts."

A series of 15 tables at the end adds to the value of this little book.

ST. PANCRAS CENTRAL ELECTRIC LIGHT STATION.

On Monday the central electric light station of the Vestry of St. Pancras was started for the first time of running, and having been fortunate enough to be present on this occasion, we are pleased to be able to give some preliminary information about this station, which is one that, because of its public ownership, will share with the Bradford electric station the interest of municipalities in all parts of the country. We do not mean to intimate that the station is yet in the position to supply lights to public or private customers, though this will doubtless be the case in a few days or weeks at most, but the machinery, which has been in process of erection for some months past, is now in part ready for work, and Monday witnessed the first trial run and the lighting up of the station.

The Vestry of St. Pancras, as will be remembered, having obtained their own provisional order in 1883—principally through the continued exertions of Mr. T. Eccleston Gibb, aided by Mr. Andrew Sweet and Dr. Walter Smith—instructed Prof. Robinson, M.I.C.E., of 7, Victoria-street, Westminster, to prepare plans and specifications for public tender. The St. Pancras Electricity Committee took extreme pains to procure the best and most complete system for their purpose. They commissioned Dr. Hopkinson, F.R.S., to colloborate with Prof. Robinson, who was retained as their engineer and adviser, and, finally, before the tenders were accepted, to make assurance doubly sure, called on Mr. W. H. Preece, F.R.S., to examine and report upon the whole scheme. This was found "very complete, thoroughly considered, and well worked out." The capacity of the station was laid out for 10,000 16-c.p. incandescent lamps and 40 arc lamps, to be supplied by means of direct-driven high-speed engines and low-tension dynamos, aided by accumulators, on the three-wire system, with a sub-station of accumulators at a distance from the generating station. The following were the accepted tenders:

1. *Buildings*: Messrs. Kirk and Randall	£4,629	0	0
2. *Boilers, etc.*: The Babcock and Wilcox Company	3,674	10	0
3. *Engines, dynamos, etc.*: Messrs. Willans and Robinson	16,327	0	0
4. *Switchboards*: Electric Construction Corporation	1,313	1	9
5. *Batteries*: Electric Construction Corporation......	2,745	12	6
6. *Trenches*: Messrs. Mowlem and Co...	9,501	0	0
7. *Mains*: Messrs. Clark, Muirhead, and Co..........	12,756	0	0
	£50,946	4	3
Add for royalty	909	0	0
Total	£51,855	4	3

The foundation of the central station was laid on November 5, 1890, with due formality, by the churchwardens of the parish of St. Pancras. Since that time work has been pushed vigorously forward, with the result that now very nearly the whole plant is erected, and all will certainly be in full working order in plenty of time for the forthcoming lighting season.

The St. Pancras electric light station lays at the back of the Hampstead-road a short distance from the upper end of Tottenham Court-road, the exact address being 47, Stanhope-street, N.W. It lays amidst a number of rather dull houses, the station site being, in reality, converted house property, the offices still being hardly distinguishable from the neighbouring houses. At the back, however, over a considerable site, extensive changes have been made, and a handsome, spacious, and convenient electric station has taken the place of dingy suburban gardens.

Passing through the offices and passages, where the workmen are at work polishing and connecting the solid strips of rolled copper which are to form the three wire distributing circuit on Messrs. Latimer Clark's system, we come into a long, spacious engine and dynamo room. All the way down this engine-room are arranged 11 sets of combined Willans and Robinson triple-expansion engines and Kapp continuous-current dynamos, the latter made by Messrs. Johnson and Phillips, Charlton. Of these 11 sets, eight engines and six dynamos are already erected, and several of the others being in a forward state of the process of erection. The dynamos, which are low-tension six-pole continuous-current machines with immense drum armatures of the newest design, are made of various voltages from 110 up to 145 volts, and of about 700 amperes each—some for supply direct on the three-wire mains, others for supplying distant points for charging batteries both in the chief station and the sub-station of batteries. Two of these engines and dynamos were running on our visit, others will be started day by day as completed.

The boiler-room is down some steps to one side, and contains a very complete arrangement for the purpose. The boilers, of the Babcock and Wilcox type, are five in number, ranged all side by side, and work at the pressure of 150lb. per square inch. As the station is far from water supply other than the town water, arrangements had to be made to use the water of condensation over and over again. Under the whole outside yard is a huge tank 17ft. deep, which, in the first place, will be filled with town water, and afterwards little more will be required except to replace that lost by evaporation. The exhaust pipes from the engine come back to a well near this tank, wherein is placed a spray condenser, supplied with water from the tank. The exhaust steam thus condensed rises in a smaller tank and overflows into the supply tank, from whence it is pumped by a Willans and Robinson pump into the boilers. When this condensed steam is not required, or the tank becomes too hot, a separate pair of Tangye pumping engines are put to work, which draw the hot water out of the hot-water tank and force it up to a cooling arrangement made of corrugated iron plates fastened around the chimney stack part way up. Down these the hot water trickles, cooling on its path, and eventually finds its way back to the large cold-water tank.

The boiler-room also contains another small engine and an air-compressor pump. This is used for forcing dry air into the conduits for the electric light mains, to keep away moisture and prevent electrical leakage.

Passing down stairs we come to a large cellar, in which the main battery of accumulator cells is arranged. This battery consists of large-sized E.P.S. cells, in two long double rows, 126 each, on solid racks, numbering thus 252 in all. These batteries were not yet in use, and are to receive their first charge of 24 hours this week. No special arrangements seemed to be made for ventilation or for fittings to resist acid fumes, and these precautions will probably have to be made.

Down one side of the engine-room is an immense and awe-inspiring switchboard, looking like the signal-box of a railway junction, with 78 handles and 20 huge omnibus bars, all painted alternately red and blue for positive and negative terminals. On this, the dynamos, cells, and various main circuits can be adjusted and balanced and the pressure of cells regulated.

The mains, as we have said, are on the three-wire system upon the plan devised by Messrs. Clark, Muirhead, and Co., a modification of the system already adopted by them for the St. James and Pall Mall station. Solid copper strips are placed edgewise, and short stoneware carriers, having three grooves, are placed at intervals, one under and one over these copper strips, the whole being screwed tightly together. The copper strips are 1¼in. wide by about $\frac{1}{10}$in. thick, as coming from the rolling mill. They are straightened, the ends punched and polished, then the ends riveted together, and the whole lengths drawn tight by screw-tackle.

Mains are already laid down the whole length of Tottenham Court-road, along High-street, Euston-road, and along Endsleigh gardens and around to the residential district of Tavistock-square. Down Tottenham Court-road a large pneumatic tube, some time ago used for the transmission of parcels by the post offices, but now disused, and the property of the Vestry, has been utilised as conduit for the electric light mains, to the saving of some considerable amount of the ratepayers' money.

The distant sub-station consists of a further set of accumulators placed in an underground chamber, dug out and built under the street just opposite the Cobden Memorial Statue, in the Hampstead-road. This sub-station will be charged by two of the dynamos wound for the voltage required, and will supply the district at the same voltage as from the central station—viz., 220 volts on the three-wire system, in two sections of 110 volts each between the house terminals.

It may be interesting here to remind our readers that the recently appointed electrical engineer to the Vestry is Mr. Barron, late outside manager to Mr. Wilson Hartnell; and to mention that the resident engineer to the station just appointed is Mr. Edgar Mapple, late superintendent of the Brighton Metropole installation, at one time with the International Telegraph Company, later with Messrs. Fielding and Platt, hydraulic engineers, of Gloucester, and more recently in charge of the construction of Mr. Holroyd Smith's electric railway at Blackpool.

The station seems, so far as can be judged from its present condition, as satisfactory an arrangement as the Vestry could desire, and both the Vestry, their advisers, and the contractors are to be congratulated upon the show they have made. The eyes of every municipal authority and of every municipal engineer will be upon them, and it therefore behoves everyone to turn out their very best work and make the station thoroughly satisfactory and complete.

THE SHORT GEARLESS MOTOR.

The part of an electric street railway motor which is by all odds most liable to break in service is the transmission machinery. The older motors of all types were furnished with metal gears. These broke so often that wood or rawhide teeth were substituted and a better service thus obtained. Nevertheless the use of a complicated train of gears has long been recognised as out of place, and several attempts have been made to overcome the defects of this construction. A successful type of gearless motor is now manufactured by the Short Electric Railway Company, of Cleveland, O.

It is possible to design an electric motor of given power (say 15 h.p.) upon two general plans. In the first, we have an armature revolving at high speed in a weak magnetic field. In the second, we have an armature revolving at low speed in a more powerful magnetic field.

The double-reduction motor, long the standard in street railway practice, is a machine of the first type—one in which the armature revolves at high speed in a weak magnetic field. Its characteristics are the following:

It has two poles separated by a wide cylindrical magnetic gap in which a long drum armature revolves.

There is the least possible amount of iron and copper in the machine for its output in power, the armature speed being a maximum with safe regard to the effect of centrifugal force. In order to bring this high armature speed to a point where it can be utilised on the car axles, two reductions are necessary, so that for a complete 30-h.p. car equipment we find eight gears and pinions, 12 double bearings requiring special self-oiling arrangements, together with a large number of bolts, nuts, and other undesirable parts.

The high speed of armature pinion and intermediate gear, and the constant wear on the other gears, make frequent replacements necessary, and at consequent large expense.

The single-reduction motor is an advance on the double-reduction motor, and is a step in the right direction—but it is only a step. In this form of machine as it is now built by the various companies, we have either a ring or a drum armature revolving between massive pole-pieces at a speed of about one-half that of the double-reduction armature. The weight of the machine is considerably increased because of the fact that the magnetic gap between the two pole-pieces is increased rather than diminished, making it necessary to increase their strength by adding to the weight of iron and copper in the fields and armature. There are still two (in one type recently brought out, four) heavy gears in each motor equipment, together with eight bearings, bolts, nuts, etc. The amount of space taken up by the motor beneath the car is somewhat reduced, but there is still a very material complication.

In the gearless motor designed by the Short Company it is believed that the final form has been reached. Referring to the machine in a general way, it will be seen from the cuts that all the gearing is absolutely eliminated, the number of bearings is reduced to two on each motor, and four in the equipment. The armature speed comes down to the minimum—namely, that of the car axles in practical operation. The noise of the gearing and "squealing" of the brushes on the commutator are entirely obviated, and there are but three wearing parts on each motor.

The intensity of the magnetic field is now at its maximum, this effect being due not to a material increase in the weight of armature and pole-pieces, but to the wholly different method of construction. Instead of two magnets we find eight; instead of a wide magnetic gap we find one extremely narrow, with consequent enormous intensity of the field of force. Instead of a drum armature of small diameter we find a ring armature of comparatively large diameter and increased leverage, the sum total being that we have here in full measure a motor of the second type—namely, one with an armature revolving at low speed in an intense magnetic field, exerting a power fully equal to the motor with gearing, and at a considerable less expenditure of current—*i.e.*, coal—since all friction of gearing is eliminated.

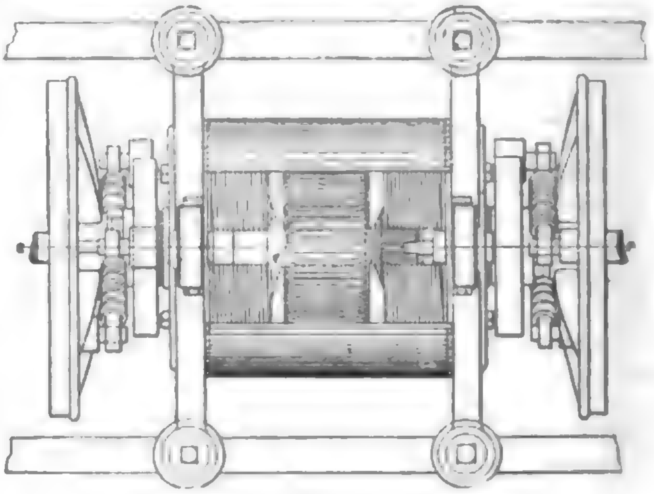

Fig. 1.

The motor is complete in itself. It is not keyed to the car axle, nor does it touch at any point. The motor as a whole can be taken off the car axle after removing a wheel. The weight of the two motors, forming a 30-h.p. equipment, is distributed over the entire truck, but it follows from what is said above that no part of the motor is borne directly upon car axles. Both motors are flexibly suspended at both ends, so that pounding on the rails, jolting and jarring of truck, crystalisation of motor frames, wheels, and axle of truck are entirely avoided. The armature is always and necessarily central.

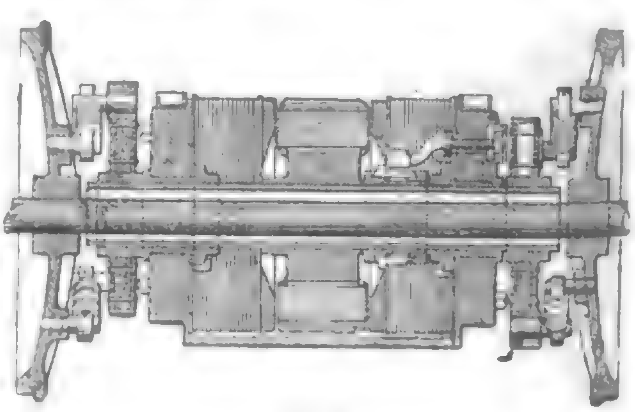

Fig. 2.

The field magnets are eight in number, four on each side of the armature. They face each other at a distance of only 10in., and thus form a most intense magnetic field. The magnets are bolted to the framework of the motor, in the centre of which are the bearings which carry the hollow armature shaft, presently to be described. The double arms running out from the framework to the cross girders on the truck make provision for the support of the entire motor. The insulation between these brackets and the girders is provided by means of heavy rubber bushings, through which pass the bolts. By removing the bolts attaching the fields to the supporting framework the coils may be quickly taken out, either for repair or to more easily get at the armature.

The armature is keyed to a hollow steel shaft, which is concentric with the axle of the truck, an inside clearance of 1in. all around being provided for. The armature proper consists of a laminated iron core, upon which are mounted separate and entirely independent coils, following the well-known methods of the Short double-reduction type of motor.

Mounted upon the hollow shaft, close to the armature is the commutator, which is protected from injury by the surrounding pole-pieces. The commutator is massive in construction and of large diameter, the idea being that, because of its massiveness and slow speed, the wear will be reduced to a minimum, and the replacing of the commutator will occur only at long intervals. On the ends of the hollow shaft in the old type of motor were rigidly mounted two discs, the peripheries of which were insulated from the hubs by the special wooden web construction which is a distinctive feature of the gearing in the Short double-reduction motor. Between the commutator and the disc on the one side and the armature and the second disc on the other were the bearings, which are carried by the motor frame.

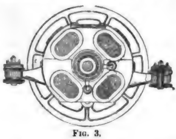

FIG. 3.

It has been before said that the motor has no connection whatever with the car axles; it follows, therefore, that it is necessary to provide means of propelling the car by making some attachment between the hollow armature shaft and the wheels. This was formerly done very simply by means of heavy coiled springs, which extended from the peripheries of the armature shaft discs to bosses on the wheels, as shown in Figs. 1 and 2. These springs were of great strength, and could pull a very heavy weight with but slight extension or compression. As they were attached to both disc and wheel upon circles of the same radius, their effort was a nearly direct circumferential pull.

The company has recently changed its method of connecting the driving sleave with the wheels, the system illustrated in Figs. 1-3 not meeting with the approval of street railway officials. In the new plan, a three-armed spider is keyed to the end of the armature sleave, as shown in Fig. 4, taken from the *Street Railway Journal*. At the end of each arm is a rubber cushion, which presses against lugs on the wheels and thus rotates them. The spider is intended to revolve the wheel it presses against in one direction only. To provide for backward as well as forward motion, the spiders are arranged on the four wheels of the truck in such a manner that the forward left and rear right wheel are driven ahead by the motor, and the other wheels are driven when the car is moved in the opposite direction.

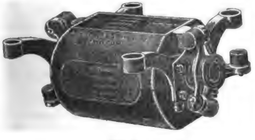

FIG. 4.

From the centre of the axle to the bottom of the casing is 12¾in. On a 36in. wheel, which we strongly advise, not only in the gearless, but in other types of motor, there is thus a clearance of 5¼in. which is ample for all purposes.

At a speed of 10 miles an hour the armature revolves at 94 revolutions per minute with a 36in. wheel. The equivalent speed of the single-reduction motor would be at least 400, and of a double-reduction motor about 1,200. The enormous advantage of the gearless form over all others is thus clearly evident.—*Engineering News.*

TELEPHONING LONDON.

"TIMES" CORRESPONDENCE.

The following, among other letters, have appeared in recent issues of the *Times* on this subject:

The DUKE OF MARLBOROUGH writes: "I am constrained to feel so much sympathy for Mr. Faithfull Begg in his efforts to seek light on the subject of the £10 rate that it has been asserted London can be telephoned for, that I will venture to offer, for the information of the public and Mr. Begg, a few further remarks on the plan that a new telephone company will adopt in carrying out this work. There are three courses open to the designer of a telephone system for the 23 square miles of London. First, you may make the whole system an overhead one, on poles and derricks, as in Berlin; secondly, you can have an entirely underground system, as in Paris; or you may have, thirdly, a partly overhead and partly underground system, which is undoubtedly the system that must be applied to London. It is manifest that each of these systems represents different scales, both of cost to set up and of expense in maintenance. The overhead system would be the cheapest to put up, but the most costly to maintain, and a larger sum for renewals would have to be provided for. The fatal difficulty with an entirely underground system is that you cannot locate faults in separate wires underground and be perpetually taking up pavements and repairing subscribers' lines. The obstructions to streets would be intolerable, and the cost would be enormous. In Paris the arterial drainage system enables the Government to take subscribers' wires into houses underground, but even this is found not to be satisfactory, and it is contemplated laying telephone subways generally. This would not be possible in London for many reasons—(1) it would interfere with the Government telegraph lines often, and (2) it would impede the laying of the electric companies' wires, many of which run under the pavements. It is not necessary to place the wires from subscribers to the local sub-exchanges underground at all. These wires, which would never have over one-third of a mile to a half-mile run, would converge from all directions overhead to the sub-exchange, which would be situated in the upper floor of some house in the centre of the area, on the top of which there would be placed a derrick which would hold from 500 to 1,000 twin wires. From this point we require from 50 to 100 twins, which should descend into the electric light or other tubes, and from there run direct to the central exchange of the district. If Parliament refuses to give telephone companies the right to lay these large cables underground, the only course will be to negotiate way-leaves for these appalling monstrosities and swing them overhead. The telephone companies only wish to know where they are going to be placed, so as not to go to large initial expense and then have to change their system after. The location of the central and sub exchanges has nothing to do with the underground question for the trunk lines.

"Now, Mr. Begg will see that it is not very difficult to calculate out the cost of this system. Given, to begin with, 50 sub-stations of 500 subscribers each, say with an average of one-third of a mile from each subscriber to the sub-exchange, and say 50 twins from each sub to each central station, you can figure out the cost for wire and attachments for the overhead portion, and also the cost of laying the 50 twin trunk cable under the pavement. These trunk cables would hardly take any room at all under the pavement, and they would never have to be disturbed; if one wire did go wrong, it is a matter of small importance. So much for wire. Now, as to exchange boards and subscribers' instruments. These are not at all costly, and the prices of various makes, both English, French, and German, are all known. The National Company in their 10 years of monopoly have worked out for future telephonists no end of valuable information on all these points. We now come to the cost of staff and renewals. As to staff, we cannot do better than take the published figures of the National. It will be seen that the telephone industry does not employ a very large staff of highly-paid experts. Girls and women do the work far better than men. As to renewals, these should proceed the whole year round, and it is simply a question of keeping so many linemen in permanent employ according to the number of subscribers, while the cost of new material is principally wire and a few tools. There never, in fact, was an industry that required so small an amount of costly plant or so little labour to maintain itself. Let any practical engineer, therefore, take a map of London and locate on it all his sub and central stations and figure in his trunk lines, supposing them to run under the pavements, and he can tell to a nicety what the telephone will cost to establish per subscriber. I have no doubt that it will work out far more costly in a 23 square-mile area than in a small country town. This no one would deny. All I maintain is that, given a system which is partly overhead and partly underground, it can be shown that with a £10 or, at the outside, £12 a year rate the business should pay a good 12 to 15 per cent. interest to the shareholders. I have not gone into the question of profits earned by the former United, but it is certain they were doing so good a business with their very experimental system that they found it possible to pool their stock at, I think, about £15 for their original £5 shares, and their divided shares stand to-day at nearly par, and paid last year a handsome dividend. Nothing, in fact, as a commercial statement to shareholders can be more satisfactory than their various balance-sheets, and I think the new telephone company are justified in taking a most sanguine view of this industry, and consequently reduce the cost to their subscribers when they open their exchanges to somewhere about £10 per subscriber, as the National have been able to do in other towns.

"As a fact, the telephone problem is child's play as compared with the electric lighting problem. This is not the place to discuss the difficulties of alternating and continuous-current systems. I have had to study both, as well as telephones, and I am confident any electrician would go gaily into telephoning London with our present knowledge where he would hesitate many times before giving an electric lighting opinion. The problem to be solved with the telephone is how to be able to put two persons into communication by a twin wire through three exchanges—two sub and one central exchange—without delay or inconvenience. If you can solve this question and calculate out the cost of laying the system on the lines I have indicated you can at once arrange your terms of subscription so as to make the yearly dividend to shareholders what you choose. You are independent of climate except for hurricanes. You are independent of the labour market almost, as you employ special operatives; you have a constant and growing business; and, whatever else one may be inclined to doubt in the question of the advisability of a £10 rate, you are quite certain of one thing—viz., that the more you give people the opportunity the more they will talk."

Mr. A. R. **Bennett** writes: "Since my name has been mentioned several times in the course of the correspondence, I would crave indulgence for a few remarks, especially as Mr. F. Faithfull Begg, in his last letter, puts the plain question, 'Can London be telephoned efficiently and profitably for a £10 subscription?' a query which I anticipated and answered in the affirmative in the paper I recently contributed to the British Association at Cardiff. If Mr. Begg has access to the National Telephone Company's books, he will find therein plenty of material to convince him of the practicability of the proposition. Especially would I refer him to the accounts relating to Dundee, Aberdeen, Inverness, Galashiels, and Dumfries, in Scotland, between the years 1883-90, and to Whitehaven and Carlisle, in England, between the years 1885-9. It was in these towns that modern telephone construction was first introduced and practised, and where the results flowing from good work and intelligent, conscientious, supervision were first demonstrated. He will find that these centres yield, or did until last year, a greater return on the capital invested than any of the richer English towns, where the bad management, which for the first two years of its existence (1881-2), characterised the old National Telephone Company, held sway long after it had ceased in the North. He will discover that a company undertaking the telephoning of moderately sized towns on a £10 tariff, and having to earn interest only on the capital actually invested, will be able to pay a dividend closely approaching 20 per cent. per annum. Now, a new company undertaking the telephoning of London would have nothing to pay for patents, and, I trust, would not be burdened with any bogus capital. It would have the example of the Scottish practice before it, and the benefit also of the Mutual Telephone Company's more recent experience in Manchester. It would likewise possess the sympathies of the London public, so long alienated by the imbecilities of the existing company. Starting thus with a fair wind it would need no favour, and only persistent bad management could prevent its earning a 10 per cent. dividend on a £10 tariff. Mr. Begg may say that Aberdeen is not London, and that what is possible in the one place may be visionary in the other. But I have had experience in managing telephonic exchange business in London as well as in Scotland, and, although I am aware that conditions differ in some respects, I also know that the variations are not radical and are capable of being allowed for. It was to equalise these differences that the plan set forth in my Cardiff paper was designed. The average length of a London subscriber's line, according to my plan, would be only 440 yards, while the average length of a Scottish subscriber's is very much greater, so that the prime cost of each would not be markedly different, even allowing for the additional expense of the twin wire which would be used in London. The approximate cost, including labour and general expenses, of each subscriber's connection would be:

Office instrument and fittings........	£3	0	0
Line (440 yards average)	5	10	0
Switchboard and other exchange fittings...	1	10	0
Total	£10	0	0

"This would join the subscriber to the sectional switch-room, but he would still have to bear a proportion of the cost of the junction wires linking the sectional-room to the central. After mature consideration I have estimated that £10 per subscriber would be a most liberal allowance for this purpose, and thus arrive at a total of £20 as the cost of each subscriber's installation. Deducting 50 per cent. of the £10 subscription for working expenses (including Post Office royalty), which prolonged experience teaches me is amply sufficient, a dividend of 25 per cent. would result. But I do not anticipate such an issue on a £10 tariff. Much of the work would have to be underground, and the special conditions existing in London must be provided for. To meet these contingencies I would add £30 to the cost of each subscriber's installation, making the total £50 per subscriber, which, with a net revenue of £5, would yield a dividend of 10 per cent. Mr. Begg may realise the weakness of his contention by asking an experienced, independent telephone engineer, who knows how to obtain material in the best markets, to jot down for him how it would be possible, with fair dealing, to expend £50 on a twin line 440 yards long and a proportion of a junction line. I have taken a £10 rate because Mr. Begg specially mentions it, but personally, as I state in my Cardiff paper, I believe that a good dividend could be earned on £8. Mr. Begg must discard all of the old company's figures and statistics except those for the northern towns I have named, for such are entirely misleading and inapplicable. They would be useful as a basis of comparison if the new company proposed to erect silver wire plated with gold, and to embellish their subscribers' instruments with emeralds, but not otherwise.

"Mr. Begg, in his first letter, expressed great belief in the efficacy of the reconstruction of the London over-house work now proceeding. I am sorry that I cannot share this faith. With the nature of this reconstruction we are made acquainted by the report of the National Telephone Company's recent annual general meeting. It consists in the introduction into London of the system I designed for the old National Company's Scottish centres so far back as 1883, and which, established at first in the face of vehement opposition, was subsequently copied in all their other provincial districts. It is now, after the lapse of eight years, being copied in London also, at the cost of many thousands of pounds, and is relied upon to extricate the company from all its troubles. But, sir, flattering to me as this expectation unquestionably is, I must point out that this system of mine, consisting of channel-iron cross-arms, upright insulators, and light bronze wire, forms but a mere detail of an efficient telephonic exchange. It is insufficient in itself to improve the service; it must be supplemented by as radical changes in every other department, and such changes, according to the reports which reach my ear, are not being made. This view is confirmed by the complaint made at the general meeting by one of the shareholders—a Mr. Harris, I believe—that, although his line had been reconstructed, his service continued as inefficient as before. That is exactly what I should have predicted, and I anticipate that, after the whole over-house reconstruction has been effected, the service generally will be as bad as it is now. I consider the position of the company the more serious because, from the statement made by their chairman at the general meeting, it is evident that they do not understand the nature of the disease which is consuming their vitals. To expect the changes he indicates to save them is absurd. His position is comparable to that of an architect who might propose to counteract the effects of unstable foundations by changing the shape of the weather vane on his building from a cock to a butterfly."

DUBLIN LIGHTING.

We make the following extract from a paper prepared by Mr. Spencer Harty, C.E., city engineer of Dublin, for the Association of Municipal and County Engineers, which meets to-day in that city.

In accordance with powers obtained, the Corporation of Dublin have now in course of construction a central electric lighting station to supply the first area covered by their license.

The streets through which the mains for public and private lighting will now be carried are as under: Westmoreland-street, Sackville-street, Mary-street, Grafton-street, College-green, College-street, D'Olier-street, Henry-street, Dame-street, Parliament-street, Capel-street (part of), provision being made for future extension of the area as required.

The public lighting will be by means of Brockie-Pell single-carbon arc lamps in series, taking a current of 10 amperes and 50 volts, and arranged to burn 16 hours without retrimming. They will be fixed on iron lampposts 21ft. high to centre of lamp, of ornamental design, and fitted with weather hoods and opalescent globes; in the base of each post will be fitted a special short-circuiting switch, to enable any lamp to be completely isolated from the circuit when necessary, and alternate lamps will be on different circuits to avoid the total extinction of light in case of temporary interruption to any one line of conductor.

The current will be generated by Brush dynamos, and will be kept constant by an automatic regulator.

The supply for the private lighting will be on the "high-tension alternating-current transformer system," the pressure in the street mains being at 2,000 volts and reduced by transformers in the consumers' houses to 50 or 100 volts as desired. The transformers are guaranteed to reproduce in the secondary circuit 95 per cent. of the energy absorbed in the primary circuit at full load, and not less than 75 per cent. at half load, and will run continuously without overheating. They will be enclosed in water-tight cast-iron cases, unless fixed in a fireproof chamber, and safety fuses will be interposed in both high and low-tension mains at the point of connection with the transformer. The amount of energy consumed will be registered by reliable meters of the Shallenberger type, with a guaranteed accuracy of 95 per cent. The mains for both public and private lighting will be carried in cast-iron pipes laid under the footways, the joints being made with gaskin and lead.

Junction-boxes of the Lowrie-Hall pattern, as used in Madrid and West Brompton, will be fixed at intersections of the streets, drawing-in and service boxes being interposed as required, and all being properly drained and fitted with water-tight covers. In every street throughout the area, a 3in. pipe will be laid on each side of the road, and on one side or other of every street a 4in. pipe will also be laid, with some few exceptions, when either a 5in. or 6in. pipe will be substituted; the service-pipes to the arc lamps and consumers' houses being 1½in. wrought iron. The conducting wires will be of high-conductivity copper wire, heavily insulated with vulcanised indiarubber, and taped, and will have a minimum insulation resistance of 5,000 megohms when laid and jointed in the pipes. The smallest size of wire allowed will be $^{7}/_{16}$ B.W.G. in area, and a "go and return" conductor will in all cases be laid in the same pipe.

The generating plant is being erected upon land belonging to the Corporation, situated at the back of the Bank of Ireland, and will cover an area of about 12,000 square feet, with room for future extension. The frontage in Fleet-street is of red brick with granite string courses, and comprises a three-storey building in which the various offices, stores, switch and test rooms will be placed, and a machinery hall 100ft. long, 50ft. wide, and 40ft. high, the latter being ventilated by swing windows in the sides and skylights in the roof. At the back of these buildings, the boiler-house, coal stores, and water-tanks are placed, and at one end a brick chimney 120ft. high from ground level is being erected. The foundations for the walls of main buildings are of cement concrete, and are carried 12ft. below the ground level, the foundations for the engines, dynamos, and chimney being carried some 2ft. lower, to the solid rock.

The engines selected for driving the private lighting plant are being built by Victor Coates and Co., of Belfast, and consist of three pairs of coupled compound non-condensing horizontal engines guaranteed to realise 280 h.p. on the flywheel of each pair, with steam pressure of 140lb., and running at 85 revolutions per minute, the diameter of the high-pressure piston being 17in., the low-pressure 34in., and the length of stroke 36in. Each cylinder is fitted with Corliss valves worked by two eccentrics with special release motion, the governor also being of specially designed high-speed type, and fitted with compensating gear which will control the speed within a maximum variation of 5 per cent. under any circumstances, and after a short space when settled will control it to 1½ per cent. variation. The crank shaft is of Siemens-Martin mild ingot steel, 11½in. diameter, and swelled to 13in. where the flywheel keys on, the main bearings being 10in. diameter and 18in. long. The flywheel, 14ft. in diameter, is built in halves carefully fitted together, and has a total weight of nine tons, of which 5¼ tons is in the rim, the latter being grooved to take twelve 1½in. ropes. All moving parts are furnished with very complete oiling arrangements, enabling the engines to run continuously if required.

Each of these engines is coupled direct by 12 1½in. ropes of Egyptian cotton to a 150-unit alternating-current dynamo of the Lowrie-Hall type, with stationary armature and revolving field magnets, with an output of 75 amperes at 2,000 volts, the approximate speed being 350 revolutions per minute, and the efficiency at full load guaranteed not less than 88 per cent., including the current required to excite the field magnets, the fields having 28 pole-pieces, giving, approximately, 4,900 complete phases per minute. The pole-pieces are securely attached to a solid wrought-iron ring, the insulation resistance between the coils and cores being not less than five megohms. The armature core is built of laminated charcoal iron sheets insulated by mica from the conductor coils of copper tape, the insulation resistance between armature coils and core being a minimum of 15 megohms, and the ends of the coils terminate in an insulating box fitted with terminals mounted on a damp-proof base, the insulating resistance between the terminals being 100 megohms. The whole is carried on an extra deep box-pattern base-plate by mild steel shaft 6in. diameter running in two plummer blocks, and having a total bearing surface equal to six times the diameter of the shaft; the bearings are of hard phosphor-bronze, in halves, and fitted with special swivelling arrangement, and each plummer block is arranged to allow of a stream of water circulating round the bearing.

The exciting current is collected by two phosphor-bronze rings on the shaft, carefully insulated. Each ring is provided with two sets of brushes and holders. Each alternator is provided with a separate exciter driven by four ¾in.

ropes from the dynamo shaft. They will be series-wound drum armature machines running at 800 revolutions per minute, and both alternators and exciters are fixed on sliding rails with tightening arrangement to allow of adjustment while running.

The public lighting plant will be driven by three vertical compound engines, each capable of realising 60 b.h.p. at a speed of 220 revolutions per minute with steam at 140lb., the high-pressure cylinder being 9in. diameter, the low-pressure 15in. diameter, and the stroke 10in.; the cylinders will be fitted with automatic and hand expansion gear adjustable while the engine is running, and the governor will be of a specially sensitive high-speed type. The flywheel will be 8ft. diameter, the face being grooved for rope driving, and the main shaft runs in three bearings. The lubrication throughout will be from stationary lubricators of combined syphon and drop feed type, designed for continuous running.

The current is generated by three Brush arc lighting dynamos, each capable of an output of 10 amperes and 2,000 volts at 800 revolutions per minute. The armatures are of laminated iron, wound with coils in 12 recesses, the opposite coils being connected in series, the free ends of the coils being brought through the hollow shaft to the commutator, each machine being mounted on sliding rails with the necessary tightening arrangements. The current is kept constant at 10 amperes by means of a Brush-Geipel automatic regulator, consisting of a series of carbon plates interposed in the main circuit, the resistance of these being varied by lever pressure, actuated by solenoids connected as a shunt across the dynamo fields.

Two main ranges of wrought-iron steam-pipes 8in. diameter extend the entire length of the engine-room, and each range is so connected with the other, with the engines, and to the boilers, and fitted with stop-valves, that any section of the steam-pipe may be removed while under steam without interfering with the supply to any engine. The stop-valves used are of the "sluice valve" type with projecting spindles, and all joints are properly faced before being made. The main exhaust pipe is of mild steel, 12in. diameter, the branch exhaust pipes from the engines being suitably curved to connect with this to avoid any back pressure. It will be carried under the engine-room floor, and covered in with removable cast-iron grating. An overhead travelling crab, lifting eight tons, permits easy handling of any of the machinery in case of breakdown.

The output of the plant thus installed is equal to 120 arc lamps of 500 watts each, and 5,000 incandescent lamps of 60 watts each, being in use at one time, with one complete spare plant in reserve in each case.

The switchroom, situated on the ground floor of the office building, is separated from the engine-room by a glazed partition, and will contain three complete sets of Lowrie-Hall automatic regulating apparatus to maintain a constant E.M.F. at the terminals of the alternators; this is effected by placing a shunt of varying resistance across the field of the exciter. The main switchboard for the private lighting plant is also of Lowrie-Hall design, as used at West Brompton station, the base being entirely of slate; the metal sleeves which are connected to the dynamo leads and circuit mains are mounted in porcelain blocks, so arranged that the operators cannot accidentally come into contact with the high-tension circuits, the cross connections being made with a double switch plug mounted on an ebonite base. By means of these plug switches, any two or more of the alternators can be coupled on to two or more of the mains, that any main or alternator not so connected can be added at will, or that any alternator can be put on to any main separately. Fusible safety junctions are fitted on the board at the points of connection with the dynamo leads and mains, and the connections are carried under the floor in brick trenches with movable covers. A synchronising board is fixed over the main switchboard, to enable the alternators to be run in parallel when necessary, with the requisite instruments to show when the machines are co-phasal. The pressure in the mains is indicated by Cardew voltmeters with large dials, and is checked on one of Sir William Thomson's standard voltmeters; the current for these is supplied by small converters arranged behind the switchboard. Spare instruments are held in reserve with the necessary appliances for recalibration. The current from the alternators is registered on ammeters on arrival on the switchboard, and the outgoing current is also registered on ammeters fixed on the mains where they leave the board, the standard ammeter being one of Sir William Thomson's.

The switchboard through which the current from the exciters passes to the alternators is provided with a switch on one side of each circuit, and a fusible safety junction on the other, ammeters are interposed in the circuits, and a Cardew voltmeter with large dial is connected to a six-way switch to enable the pressure in any circuit to be ascertained. The switchboard for the public lighting plant is fitted with three main switches and three circuit switches, arranged so that any of the circuits and dynamos can be interchanged; the three circuits can also be placed in series. An ammeter is interposed in each circuit.

The test room, which is placed adjoining the switchroom, is fitted with a very complete set of instruments for testing the condition of the various circuits and machines, and recalibrating the numerous ammeters and voltmeters in use in the station; the adjustment of meters and testing transformers will also be carried out here. The Thomson reflecting galvanometer is mounted on a concrete pillar, carried some 12ft. below the ground-line to minimise vibration. The Wheatstone bridge and testing battery will be permanently connected on an insulated testing table in a convenient form.

Steam will be generated for the engines in four Babcock and Wilcox water tube boilers, each capable of evaporating 8,500lb. of water per hour at a pressure of 150lb. on the square inch, the coal consumption at full work being guaranteed not to exceed 1lb. of Welsh steam coal for every 9lb. of water evaporated. The total heating surface in each boiler is 2,530 square feet, of which 51 square feet is grate surface. They will be set in batteries of two, the brickwork being faced with white glazed brick bedded in fireclay, and each boiler will consist of 14 sections of eight lap-welded wrought-iron tubes 4in. diameter and 18ft. long, fitted in the usual way, and connected at each end with "uptakes" and "down-takes," to two steam and water drums 36in. diameter and 23ft. 7in. long, built of ⅜in. steel plates, the longitudinal seams being double riveted. The boilers will be suspended from wrought-iron girders supported on cast-iron pillars and will be entirely independent of the brickwork; they will have the usual steam and water fittings for boilers of this class, and will be subjected to an hydraulic test of 250lb. on the square inch after erection. The boilers will be fed by three Worthington steam pumps, each one capable of supplying sufficient water to two of the boilers when fully loaded, and arranged so that any boiler can supply any pump with steam, entirely independent of the main steam-pipes.

Water-tanks capable of holding a supply for five hours at full load will be erected on brick piers over the coal store, and a direct connection will be made between the Corporation water main and the steam pumps, to be used in an emergency. The feed-water will be passed through three of Berryman's feed-water heaters, each heating a sufficient quantity for two of the boilers at full load; they will be placed at the foot of the chimney, and by means of suitable by-passes and valves the exhaust steam can be sent through any or all of the heaters, or past them direct into the chimneys. The main flue will be built of firebrick, sides and top set in fireclay, with a concrete bottom; the base of the chimney will be lined internally for 20ft. with a ring of firebrick with a 2in. air space between.

The chimney itself has a solid bed of concrete, 20ft. square and 3ft. thick, resting on rock 16ft. below the ground level, and will have a total height of 140ft., the internal diameter being 8ft. It will be fitted with a solid copper tape conductor with rod and points, and will be earthed on the 6in. water main supplying the station.

The Corporation will bring their surface lines, free of expense, to any consumer's premises situated within 30ft. of any of their mains, an extra charge being made for any greater distance, and in all cases the consumer's installation must be passed by the Corporation inspector before connection will be completed, and be in accordance with the rules laid down by them to secure efficiency and safety. The transformer and high-tension safety fuses supplied by the Corporation, when not enclosed in an iron case, will be placed in a suitable protecting chamber supplied by the consumer. A double-pole switch and safety fuses will form part of the consumer's installation immediately where the low-tension circuit leaves the transformer case.

The charge to the consumer will be either by special contract or by meter as may be desired, the minimum charge per quarter being £2 for any quantity up to 60 units. For any quantity over 60 units and under 100 units per quarter, 8d. per unit. For any quantity over 100 units per quarter, 7d. per unit. Hire of meter per quarter, 5s. Hire of transformer, primary safety fusible cut-outs—

		£	s.	d.
For	25 16-c.p. lamps per quarter	0	5	0
,,	50 ,, ,, ,,	0	10	0
,,	100 ,, ,, ,,	1	0	0
,,	150 ,, ,, ,,	1	10	0
,,	200 ,, ,, ,,	2	0	0

The meters will, of course, be fixed on the low-tension mains, their accuracy being guaranteed by the Board of Trade inspectors, and the current will be available for 23 hours per diem.

The entire cost of the works as at present designed will be about £31,000, and will be maintained by, and kept under the control of, the Corporation.

REPORT OF THE N. E. L. A. COMMITTEE ON TABULATING WIRING AND INSURANCE RULES.*

CLASS A.—CENTRAL STATIONS.

FOR LIGHT OR POWER.

These rules apply to dynamo-rooms in isolated plants connected with or detached from buildings used for other purposes; also to all varieties of apparatus, of both high and low potential.

Generators or Motors—Must be :

1. Located in a dry place.
2. Insulated on floors or base frames which must be kept filled to prevent absorption of moisture, and also kept clean and dry.
3. Not exposed to flying or combustible materials.
4. Each covered with a waterproof cover when not operating.

In no case must a generator be placed in a room where any hazardous process is carried on, such as the working-room of a cotton, jute, flax, woollen, or flour mill.

Care and Attendance.—A competent man must be kept on duty in the room where generators are operating.

Oily waste must be kept in metal cans and removed daily.

Conductors.—From generators, switchboards, rheostats, or other instruments, and thence to outside lines, conductors must be :

1. In plain sight.
2. Wholly on non-combustible insulators, such as glass or porcelain.
3. Separated from contact with floors, partitions, or walls through which they may pass, by non-combustible insulating tubes.
4. Kept rigidly so far apart that they cannot come in contact.
5. Covered with non-inflammable insulating material sufficient to prevent accidental contact.
6. Ample in carrying capacity to prevent heating. (See capacity of wires table.)
7. Connected by splices or joints equal in carrying capacity to the conductors themselves, soldered if necessary to make them efficient and permanent.
8. When under floors or in distributing towers, placed in spaces ample for inspection and ventilation, and provided with special insulating covering.

Switchboards—Must be :

1. So placed as to make it impossible to communicate fire to surrounding combustible material; accessible from all sides when the connections are on the back; or may be placed against a brick or stone wall when the connections are entirely on the face.
2. Kept free from moisture.
3. Made of non-combustible material, or of hard wood, filled to prevent absorption of moisture.
4. Equipped with bars and wires in accordance with rules 1, 2, 4, 5, 6 and 7 for placing interior conductors.

Resistance-boxes and Equalisers—Must be :

1. Equipped with metal or non-combustible frames.
2. Treated as sources of heat.
3. Placed on the switch or a distance of a foot from combustible material, or separated therefrom by asbestos or cement.

Lightning Arresters—Must be :

1. Attached to each side of every overhead circuit connected with the station.
2. In plain sight.
3. On the switchboard or in an equally accessible place, away from combustible material.
4. Connected with at least two earths by separate wires of large size.
5. So constructed as not to maintain an arc after the discharge is passed.

Testing.—All series and alternating circuits must be tested every two hours while in operation to discover any leakage to earth, abnormal in view of the potential and method of operation.

All multiple arc low-potential systems (300 volts or less) must be provided with an indicating or detecting device, readily attachable, to afford easy means of testing where the station operates perpetually.

Data obtained from all tests must be preserved for examination by insurance inspectors.

CLASS B.—ARC (SERIES) SYSTEMS.

Overhead Conductors.—All outside overhead conductors (including services) must be :

1. Covered with some insulating material, not easily abraded.
2. Firmly secured to properly insulated and substantially-built supports, all the wires having an insulation equal to that of the conductors they confine.
3. So placed that moisture cannot form a cross-connection between them, not less than a foot apart, and not in contact with any substance other than proper insulating supports.
4. At least 7ft. above the highest point of flat roofs, and at least 1ft. above the ridge of pitched roofs, over which they pass, or to which they are attached.
5. Protected whenever necessary, in view of possible accidents to conductors or supports, from possibility of contact with other conducting wires or substances to which current may leak, by *dead insulated guard irons or wires.* Special precautions of this kind must be taken where sharp angles occur, or where any wires might possibly come in contact with electric light or power wires.
6. Provided with petticoat insulators of glass or porcelain. Porcelain knobs and rubber hooks are prohibited.
7. So spliced or joined as to be both mechanically and electrically secure without solder. They must then be soldered to ensure preservation, and covered with an insulation equal to that on the conductors.

The following formula for soldering fluid is approved :

Saturated solution of zinc	5 parts.
Alcohol	4 parts.
Glycerine	1 part.

Conductors should not be run over, or attached to, buildings other than those in which light or power is being, or is to be, used, but on separate poles or structures, always easily inspected.

Service Blocks must be covered over their entire surface with at least two coats of waterproof paint and so maintained.

Telegraph, telephone, and similar wires must not be placed on the same arm with electric or power wires, and *should not* be placed on the same structure or pole.

INTERIOR CONDUCTORS.

All Interior Conductors—Must be :

1. Where they enter buildings from outside terminal insulators to and through the walls, covered with waterproof insulation, and must have drip loops outside, preferably slanting upward toward the inside and bushed with waterproof and non-combustible insulating tube.
2. Arranged to enter and leave the building through a double-contact service switch, which will effectually close the main circuit and disconnect the interior wires when it is turned "off." The switch must be so constructed that it shall be automatic in its action, not stopping between points when started, and prevent an arc between the points under all circumstances; it must indicate on inspection whether the current be "on" or "off," and be mounted on a non-combustible base in a position where it can be kept free from moisture and easy of access to police or firemen.
3. Always in plain sight, never covered, except in special cases, where an armoured tube may be necessary.
4. Covered in all cases with a moisture-proof non-combustible material that will adhere to the wire, not fray by friction, and bear a temperature of 150deg. F. without softening.
5. In dry places, kept rigidly apart at least 10in., except when covered (in addition to insulation) by a water-proof non-conducting and non-inflammable tubing, which must be strong enough to protect the insulation covering from injury. Conductors thus placed may be run not less than 3in. apart, and be fastened with staples, under which are placed mechanically rigid insulating strips or saddles of greater width than the metal of the staple, by which possibility of injury to the tube may be prevented.
6. In damp places, attached to glass or porcelain insulators, and separated 10in. or more.
7. When passing through walls, floors, timber, or partitions, treated as in central stations under like conditions.

LAMPS AND OTHER DEVICES.

Arc Lamps—Must be in every case :

1. Carefully isolated from inflammable material.
2. Provided at all times with a glass globe surrounding the arc, securely fastened with a closed base. No broken or cracked globes may be used.
3. Provided with a hand switch, also an automatic switch, that will shunt the current around the carbons should they fail to feed properly.

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* Presented and adopted by the National Electric Light Association, Montreal, P. Q., September 10, 1891. [It seems to us that most of this report is as well worth consideration in England, and in fact wherever electricity is used, as in America.—ED. *E.E.*]

4. Provided with reliable stops to prevent carbons from falling out in case the clamps become loose.

5. Carefully insulated from the circuit in all their exposed parts.

6. Where inflammable material is near or under the lamps, provided with a wire netting around the globe, and a spark-arrester above, to prevent escape of sparks, melted copper, or carbon.

Incandescent lamps on series circuits, having a maximum potential of 350 volts or over, must be governed by the same rules as for arc lights, and each series lamp provided with a hand switch and automatic cut-out switch; when lights are in multiple series, such switches and cut-outs must not control less than a single group of lights. Electromagnetic devices for switches are not approved.

Under no circumstance will incandescent lamps on series circuits be allowed to be attached to gas fixtures.

CLASS C.—INCANDESCENT (LOW PRESSURE) SYSTEMS. THREE HUNDRED VOLTS OR LESS.

Overhead Conductors.

Outside Overhead Conductors—Must be:

1. Erected in accordance with general rules for arc (series) circuit conductors.

2. Separated not less than 6in., where they enter buildings as service conductors, and be provided with a double-pole fusible cut-out, as near as possible to the point of entrance to the building, and outside the walls when practicable.

Underground Conductors.

Underground Conductors—Must be:

1. Provided with suitable protecting devices at the ends of tube or conduit services inside the walls of buildings, as a guard against moisture and injury.

2. Terminated at a properly placed double-pole house cut-out.

3. Of specially insulated conductors after leaving the tube or conduit, and separated by at least 10in., until the double-pole cut-out is reached.

Inside Wiring.

Wire should be so placed that in the event of the failure or deterioration of their insulating covering, the conductors will still remain insulated.

At the entrance of every building there shall be a double-pole switch placed in the service conductors, whereby the current may be entirely cut off.

Conductors—Must not be:

1. Of sizes smaller than No. 16 B. and S., No. 18 B.W.G., or No. 3 E.S.G.

2. Lead or paraffin covered.

3. Covered with soft rubber tube

4. Laid in mouldings of any kind in damp places.

5. Laid in mouldings with open grooves against the wall or ceiling.

6. Laid in mouldings where less than half an inch of solid insulation is between parallel wires, and between wires and walls or ceilings.

Mouldings, where admissible, must have at least two coatings of water-proof paint or be impregnated with a moisture repellent.

Cleatwork is not desirable, and cleats must *not* be used unless:

1. In a very dry place.

2. In a place perfectly open for inspection at any time.

3. They are of porcelain, or well-seasoned wood, filled to prevent absorption of moisture.

4. They are so arranged that wires of opposite polarity, with a difference of potential of 150 volts or less, will be kept at least 2½in. apart, and that where a higher voltage is used this distance be increased proportionately.

5. There is a backing provided of wood at least ¾in. thick, well seasoned and filled, to prevent absorption of moisture.

Metal Staples must never be used to fasten conductors unless:

1. Provided with an insulating sleeve or saddle rigidly attached to the metal of the staple, and having such strength and surface as to prevent mechanical injury to the insulation of the conductor.

2. Under conditions in which cleatwork would be acceptable, or where driven into a moulding specially adapted for open work.

Special Wiring.

Wherever conductors cross gas, water, or other metallic pipes, or any other conductors or conducting material (except arc light wires), they should be separated therefrom by some continuous non-conductor at least 1in. In crossing arc light wires the low-tension conductors must be placed at a distance of at least 6in. In wet places an air space must be left between conductors and pipes in crossing, and the former must be run in such a way that they cannot come in contact with the pipe accidentally. Wires should be run over all pipes upon which condensed moisture is likely to gather, or which by leakage might cause trouble on a circuit.

In breweries, dye-houses, paper and pulp mills, or other buildings specially liable to moisture, all conductors, except where used for pendants, must be:

1. Separated at least 6in.

2. Carefully put up.

3. Supported by porcelain or glass insulators

Moisture proof and non-inflammable tubing may be accepted in lieu of such construction.

No switches or fusible cut-outs will be allowed in such places.

Interior Conduits—Must not be:

1. Combustible.

2. Of such material as will be injured or destroyed by plaster or cement, or of such material as will injure the insulation of the conductor.

3. So constructed or placed that difficulty will be experienced in removing or replacing the conductors.

4. Subject to mechanical injury by saws, chisels, or nails.

5. Supplied with a twin conductor in a single tube where a current of more than 10 amperes is expected.

6. Depended upon for insulation. The conductors must be covered with moisture-proof material.

The object of a tube or conduit is to facilitate the insertion or extraction of the conductors, to protect them from mechanical injury, and, as far as possible, from moisture.

Twin tube conductors must not be separated from each other by rubber or similar material, but by cotton or other readily carbonisable substance.

Conductors passing through walls or ceilings must be encased in a suitable tubing, which must extend at least 1in. beyond the finished surface, until the mortar or other similar material be entirely dry, when the projection may be reduced to ½in.

Double-Pole Safety Cut-outs—Must be:

1. Placed where the overhead or underground conductors enter a building and join the inside wires.

2. Placed at every point where a change is made in the size of the wire (unless the cut-out in the larger wire will protect the smaller). This includes all the flexible conductors. All such junctions must be in plain sight.

3. Constructed with bases of non-combustible and moisture-proof material.

4. So constructed and placed that an arc cannot be maintained between the terminals by the fusing of the metal.

5. So placed that on any combination fixture, no group of lamps requiring a current of six amperes or more shall be ultimately dependent upon one cut-out.

6. Wherever used for more than six amperes, or where the plug or equivalent device is not used, equipped with fusible strips or wires provided with contact surfaces or tips of harder metal, soldered or otherwise, having perfect electrical connection with the fusible part of the strip.

Safety Fuses must be so proportioned to the conductors they are intended to protect, that they will melt before the maximum safe carrying capacity of the wire is exceeded.

All fuses, where possible, must be stamped or otherwise marked with the number of amperes equal to the safe carrying capacity of the wire they protect.

All cut-out blocks when installed must be similarly marked.

The safe carrying capacity of a wire changes under different circumstances, being about 40 per cent. less when the wire is closed in a tube or piece of moulding, than when bare and exposed to the air, when the heat is rapidly radiated. It must be clearly understood that the size of the fuse depends upon the size of the smallest conductor it protects, and not upon the amount of current to be used on the circuit. Below is a table showing the safe carrying capacity of conductors of different sizes in Birmingham, Brown and Sharpe, and Edison gauges, which must be followed in the placing of interior conductors.

Brown & Sharpe.		Birmingham		Edison Standard	
Gauge No.	Amperes.	Gauge No.	Amperes.	Gauge No.	Amperes.
0000	175	0000	175	200	175
000	145	000	150	180	160
00	120	00	130	140	135
0	100	0	100	110	110
1	95	1	95	90	95
2	70	2	85	80	85
3	60	3	75	65	75
4	50	4	65	55	65
5	45	5	60	50	60
6	35	6	50	40	50
7	30	7	45	30	40
8	25	8	35	25	35
10	20	10	30	20	30
12	15	12	20	12	20
14	10	14	15	8	15
16	5	16	10	5	10
—	—	18	6	3	5

Switches—Must:

1. Be mounted on moisture-proof and incombustible bases, such as slate or porcelain.

2. Be double-pole when the circuits which they control are connected to fixtures attached to gas-pipes, and when six amperes or more are to pass through them.

3. Have a firm and secure contact, must make and break readily, and not stick when motion has once been imparted by the handle.

4. Have carrying capacity sufficient to prevent heating above the surrounding atmosphere.

5. Be placed in dry, accessible places, and grouped as far as possible, being mounted, when practicable, upon slate or equally indestructible back boards.

Motors.—In wiring for motive power, the same precautions must be taken as with the current of the same volume and potential for lighting. The motor and resistance-box must be protected by a double-pole cut-out, and controlled by a double-pole switch.

Arc Lights on Low-Potential Circuits—Must be:

1. Supplied by branch conductors not smaller than No. 12 B. and S. gauge.

2. Connected with main conductors only through double-pole cut-outs.

3. Only furnished with such resistances or regulators as are enclosed in non-combustible material, such resistances being treated as sources of heat.

4. Supplied with globes protected as in the case of arc lights on high-potential circuits.

Fixture Work.

1. In all cases where conductors are concealed within or attached to fixtures, the latter must be insulated from the gas-pipe system of the building.

2. When wired outside, the conductors must be so secured as not to be cut or abraded by the pressure of the fastenings or motion of the fixtures.

3. All conductors for fixture work must have a waterproof insulation that is durable and not easily abraded, and must not in any case be smaller than No. 16 B. and S., No. 18 B.W.G., or No. 3 E.S.G.

4. All burrs or fins must be removed before the conductors are drawn into a fixture.

5. The tendency to condensation within the pipes must be guarded against by sealing the upper end of the fixture.

6. No combination fixture in which the conductors are concealed in a space less than ¼in. between the inside pipe and the outside casing will be approved.

7. Each fixture must be tested for possible "contacts" between conductors and fixture, and for "short circuits," before the fixture is connected to its supply conductors.

8. The ceiling blocks of fixtures should be made of insulating material.

Electric Gas Lighting.

Where electric gas lighting is to be used on the same fixture with the electric light:

1. No part of the gas-piping or fixture shall be in electrical connection with the gas lighting circuit.

2. The wires used with the fixture must have a non-inflammable insulation, or, where concealed between the pipe and shell of the fixture, the insulation must be such as is required for fixture wiring for the electric light.

3. The whole insulation must test free from "grounds."

4. The two installations must test perfectly free of connection with each other.

Pendants and Sockets.

No portion of the lamp socket exposed to contact with outside objects must be allowed to come into electrical contact with either of the conductors.

Cord Pendants—Must be:

1. Made of conductors, each of which is composed of several strands insulated from the other conductor by a mechanical separator of carbonisable material, and both surrounded in damp places with a moisture-proof and a non-inflammable layer.

2. Protected by insulating bushings where the cord enters the socket.

3. So suspended that the entire weight of the socket and lamp will be borne by knots, above the point where the cord comes through the ceiling block or rosette, in order that the strain may be taken from the joints and binding screws. All sockets used for wire or cord pendants should have openings at least equal to ⅜in. gas-pipe size.

4. Allowed to sustain nothing heavier than a four-light cluster, and in such a case special provision should be made by an extra heavy cord or wire as a mechanical reinforcement.

5. Equipped with keyless sockets as far as practicable, controlled by wall switches. In no case may a lamp giving more than fifty (50) candle-power be placed in a key-socket on a flexible pendant.

CLASS D.—ALTERNATING SYSTEMS.

Converters or Transformers.

Converters—Must not:

1. Be placed inside of any building except the central station, unless as hereinafter provided.

2. Be placed in any but metallic or non-combustible cases.

3 Be attached to the outside walls of buildings, unless separated therefrom by substantial insulating supports.

4. Be placed in any other than a dry and convenient location (which can be secured from opening into the interior of the building, such as a vault) when an underground service is used.

5. Be placed without safety fuses at the junction between main and service conductors and safety fuses in the secondary circuits where they will not be affected by the heat of the converter.

Primary Conductors.

In those cases where it may not be possible to exclude the transformers and primary wires entirely from the building, the following precautions must be strictly observed:

1. The transformer must be located at a point as near as possible to that at which the primary wires enter the building.

2. Between these points the conductors must be heavily insulated with a coating of moisture-proof material, and, in addition, must be so covered and protected that mechanical injury to them or contact with them shall be practically impossible.

3. The primary conductors, if within a building, must be furnished with a double-pole switch, and also with an automatic double-pole cut-out where the wires enter the building, or where they leave the main line, on the pole or in the conduit. These switches should, if possible, be enclosed in secure and fireproof boxes outside the building.

4. The primary conductors, when inside a building, must be kept apart at least 10in., and the same distance from all other conducting bodies.

Secondary Conductors.

The conductors from the secondary coil of the transformer to the lamps or other translating devices must be installed according to the rules for "inside wiring" for "low-potential systems."

CLASS E.—ELECTRIC RAILWAYS.

Power Stations.

All rules pertaining to arc light wires and stations shall apply (so far as practicable) to street railway power stations and their conductors.

Railway Systems with Ground Return.

Electric railway systems in which the motor cars are driven by a current from a single wire, with ground or floor return circuit, are prohibited *except* as hereinafter provided:

1. When there is no liability of other conductors coming in contact with the trolley wire.

2. When the location of the generator is such that the ground circuit will not create a fire hazard to the property.

3. When an approved automatic circuit breaker or other device that will immediately cut off the current in case the trolley wires become grounded is introduced in each circuit as it leaves the power station. This device must be mounted on a fireproof base and be in full view of the attendant.

Trolley Wires.

Trolley Wires—Must be:

1. No smaller than No. 0 B. and S. copper, or No. 4 B. and S. silicon bronze, and must readily stand the strain put upon them when in use.

2. Well insulated from their supports, and in case of the side or double-pole construction, the supports shall also be insulated from the poles immediately outside the trolley wire.

3. Capable of being disconnected at the power-house, or of being divided into sections, so that in case of fire on the railway route, the current may be shut off from the particular section and not interfere with the work of the firemen in extinguishing the flames. This rule also applies to feeders.

4. Safely protected against contact with all other conductors.

Car Wiring.

All wires in cars must be run out of reach of the passengers, and shall be insulated with a waterproof insulation.

Lighting and Railway Power Wires.

Lighting and power wires must not be permitted in the same circuit with trolley wires with a ground return, except in street railway cars, car-houses, and power stations. The same dynamo may be used for both purposes, provided the connection from the dynamo for each circuit shall be a double-pole switch so arranged that only one of the circuits can be in use at the same time.

CLASS F.—BATTERIES.

When current for light and power is taken from primary or secondary batteries, the same general regulations must be observed as apply to such wires fed from dynamo generators, developing the same difference of potential.

CLASS G.—MISCELLANEOUS.

1. The wiring in any building must test free from "grounds" before the current is turned on. This test may be made with a magneto that will ring through a resistance of 20,000 ohms, where currents of less than 250 volts are used.

2. No ground wires for lightning arresters may be attached to gas-pipes with the building.

3. All conductors connecting with telephone, district messenger, burglar-alarm, watch-clock, electric time, and other similar instruments must, if in any portion of their length they are liable to become crossed with circuits carrying currents for light or power, be provided near the point of entrance to the building with some protective device which will operate to shunt the instruments in case of a dangerous rise of potential, and will open the circuit and arrest an abnormal current flow. Any conductor normally forming an innocuous circuit may become a source of fire hazard if crossed with another conductor through which it may become charged with a relatively high pressure.

(Signed) A. J. DeCamp, chairman.
M. D. Law. Stephen E. Barton.
Wm. Brophy. T. Carpenter Smith.

ELECTRIC LIGHTING IN CHELSEA.

In his report for 1890-91 to the Chelsea Vestry, the surveyor (Mr. T. W. E. Higgens) says:

> During the past year the electric lighting industry has been making quiet progress in the parish of Chelsea.
>
> *The Chelsea Electricity Supply Company*, which is the principal company in Chelsea, have added the Lowndes-square district to their area of supply and laid their mains therein. They subsequently obtained consent to the addition of that portion of the parish east of Beaufort-street which had not been previously included in their area of supply. Owing to the prevalence of dense fogs and other causes this company applied to the Board of Trade to be permitted to discontinue supplying electricity during the earlier hours of the day, but this permission was not given. At the end of February last this company were lighting 215 houses.
>
> *The London Electric Supply Corporation* have not carried out any works in Chelsea during the past year, and are still only lighting two houses.

The Cadogan Electric Light Company have laid mains from Tite-street through Tedworth-square and Smith-street to King's-road in accordance with their agreement with the Vestry. The company have been re-formed under the title of the New Cadogan and Belgrave Electric Supply Company, and at the time of the re-formation they suggested to the Vestry that their agreement as to laying mains should be transferred to the new company. The Vestry, however, suggested that the company should apply for a provisional order in the usual manner. This was done, and at the end of the financial year the suggested order was under discussion. At the end of February the company were lighting 16 houses in Chelsea.

The number of houses lighted by electricity in Chelsea was :

	1889-90	1890-91
Chelsea Electricity Supply Company......	113	215
Cadogan Electric Light Company	25*	16
London Electric Supply Corporation......	1	2
	139	233

* This probably included some houses in the Belgravian district.

It is thus seen that there have been about 100 houses which have adopted electric light during last year.

In May, 1890, the Board of Trade forwarded a draft of regulations which it was proposed to serve upon the London Electric Supply Company. Two slight alterations which I suggested were approved by the Vestry, submitted to the Board of Trade, and subsequently adopted by them and included in the regulations.

Overhead Wires, etc.—During the year, I submitted a somewhat lengthy report on the subject of overhead wires, underground pipes, mains, etc., and also submitted plans showing (as far as possible) the positions of all such pipes, wires, mains, etc. [This report will be found in our issue for March 13 last.—Ed. *E.E.*]

CITY NOTES.

Brazilian Submarine Telegraph Company.—The receipts for the week ended September 18 amounted to £4,849.

Eastern Extension Telegraph Company.—The Directors have declared an interim dividend for the quarter ended 30th June of 2s. 6d. per share.

City and South London Railway.—The receipts for the week ending September 20 were £684, against £664 for the week ending 13th inst.

Globe Telegraph Company.—The Directors have declared an interim dividend of 3s. per share on the preference shares, and 2s. per share on the ordinary shares.

Western and Brazilian Telegraph Company.—The receipts for the week ended September 18, after deducting 17 per cent. of the gross receipts payable to the London-Platino Company, were £3,780.

West India and Panama Telegraph Company.—The estimated receipts for the half-month ended September 15 were £1,855, as compared with £2,446 in the corresponding period of last year. The May receipts, estimated at £5,895, realised £5,992.

Winfields.—The Directors of Winfields, Limited, report a depression in the year ending June 30. The sales had decreased £2,600. The accounts showed a profit of £1,826. 19s. 4d., £1,000 of which has been written off for depreciation, etc.; the balance added to that of last year, £3,592. 15s. 9d., makes an undivided profit of £4,419. 15s. 1d., which is required in the business, and no dividend is declared. The Directors have this year issued £4,400 second debentures, and are prepared to receive further £100 5 per cent. debentures, for which the security is sound.

Direct Spanish Telegraph Company.—The report of the Directors for the half-year to June 30 states that after providing for debenture interest there is a profit balance of £5,525. With the exception of the interruption of the Barcelona cable from the 3rd to the 14th of April, the cables and the land lines in connection with them continued in good working order throughout the half-year. Of the profit balance £2,500 had been put to the reserve fund, which now amounts to £25,928, leaving £3,025, out of which the Directors recommend a dividend at the rate of 10 per cent. on the preference and one at the rate of 5 per cent. per annum, tax free, on the ordinary shares, £270 being carried to the contingencies account.

PROVISIONAL PATENTS, 1891.

SEPTEMBER 14.

15522. **Improvements in or relating to conductors for dynamo-electric machines, electric motors, and alternate or direct current transformers.** Gilbert Betteley Luckhoff, 214, Whitehorse-road, Croydon, Surrey.

15529. **Indicating the direction of the wind on a dial by means of electricity, called "an electric vane."** Edward James Starr, Crawley Down, Sussex.

15542. **Improvements in telephones.** David Urquhart, 11, Victoria-street, Westminster, London. (L. H. Despeissis, France.)

15575. **Improvements in galvanic batteries.** August de Meritens, 47, Lincoln's-inn-fields, London.

15579. **An improved arrangement of automatic electric switch and cut-out for use in charging secondary cells and for similar purposes.** Octavius March, 20, High Holborn, London.

SEPTEMBER 15.

15597. **An improved battery.** Cecil Urquhart Fisher, 45, Holborn Viaduct, London. (Roscoe Henry Thompson, United States.) (Complete specification.)

15621. **Improvements in the method of making the plates or elements of a secondary or storage battery.** Stanley Charles Cuthbert Currie, 323, High Holborn, London. (Complete specification.)

15644. **Improvements in and relating to ceiling blocks or roses and cut-outs for use in connection with electric light and other circuits.** Edwin Truman Greenfield and Charles Jacob Kintner, 45, Southampton-buildings, London. (Complete specification.)

SEPTEMBER 16.

15697. **Improvements in electric telephonic transmitters.** John Graham, 46, Belmont-street, Haverstock-hill, London.

15705. **Electric signalling on railways to trains in motion or otherwise.** John Watkinson and George Prince, 27, Albert-terrace, Burley Fields, Leeds.

SEPTEMBER 17.

15749. **Improvements in electric arc lamps.** William Hopkin Akester, 57, Chancery-lane, London.

15768 **Improvements in the method of and apparatus for distributing electricity.** Charles James Hall, of the firm of John Fowler and Co., Limited, Sunbridge-chambers, Bradford, Yorkshire.

15794. **Improvements in electric arc lamps.** Frederic William Dickinson, 323, High Holborn, London.

SEPTEMBER 18.

15834. **Improvements for carriers for conical shades for electric or other lamps.** Bernard Mervyn Drake and John Marshall Gorham, 66, Victoria-street, Westminster, London.

15849. **Improvements in telephonic instruments.** Arthur Thomas Collier, 70, Market-street, Manchester.

15868. **Improvements in electric arc lamps.** Hippolyte Hegner and Ladislas Lenczewski, 46, Lincoln's-inn-fields, London.

15872. **Improvements connected with electric motors and elevators.** The American Elevator Company, 55, Chancery-lane, London. (Otis Bros. and Co., United States.)

SEPTEMBER 19.

15882. **An improved switch holder for incandescent electric lamps.** Henry Heartfield, 42, Pitlake, Croydon.

15922. **Improvements in electrical incandescent lamps** Reginald Haddan, 18, Buckingham-street, Strand, London. (Gaston Dedreux, Germany.)

15937. **Improvements in electrical measuring instruments.** John Corry Fell, 1, Queen Victoria-street, London. (Edward Weston, United States.)

SPECIFICATIONS PUBLISHED.

1890.

13570. **Telegraphic apparatus.** Egger. 9d.

16057. **Pillars and pendants for electric lamps.** Evered and Rudling. 8d.

16223. **Electric motors.** Burrows. 8d.

16963 **Placing conductors for electricity underground.** Hartnell. 8d.

17322. **Telephones.** Hartmann and Braun. 8d.

17941. **Charging accumulator batteries.** Siemens Bros. and Co., Limited. (Siemens and Halske). 8d.

19076. **Electric safety fuses.** Mordey. 6d.

1891.

4468. **Casings for electrical switches, etc.** Abel. (Messing.) 6d.

9876. **Telegraph block systems of railway traffic control.** Coombes and Rowe. 8d.

11201. **Telephonic communication.** Sack and others. 11d.

12455. **Electric locomotives** Wetter. (Bonneau.) 6d.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Brush Co.	—	3½
— Pref.	—	2
India Rubber, Gutta Percha & Telegraph Co.	10	19½
House-to-House	5	5
Metropolitan Electric Supply	—	10½
London Electric Supply	5	2½
Swan United	3¾	5
St. James'	—	7¾
National Telephone	5	4¾
Electric Construction............	10	7¼
Westminster Electric............	—	5¾

NOTES.

Electro-Harmonics.—The first smoking concert is to-night (Friday) at St. James's Hall.

Western Australia.—It is proposed to establish a telephone exchange at Albany, Western Australia.

Brussels.—The time for receiving tenders for the lighting of Brussels has been extended to noon on 30th October.

Kilkenny.—It has been decided by the Kilkenny Town Council to introduce electricity for the public lighting of the streets.

Champs Elysees.—Active steps are being taken in the formation of the electric lighting company for the Champs Elysées sector at Paris.

Bedford.—At a public meeting of the ratepayers of Bedford last week it was decided in favour of the Town Council introducing the electric light.

Obituary.—We are grieved to record the death, at his residence at Greenwich, of Mr. Thomas John Brown, chief electrician to the Telegraph Construction and Maintenance Company.

Postponement of O.S.A. Dinner.—The Old Students' dinner, that was to take place to-morrow, at the Holborn Restaurant, at 7 o'clock, is postponed till Oct. 31, at the same place and hour.

Chiswick Fire Brigade.—The Chiswick Local Board, with a desire to make their fire brigade as efficient as possible, have fixed 10 electric alarm-posts fitted with all the latest improvements.

Reigate.—The Reigate Town Council last week decided to take no steps at present towards obtaining a provisional order for lighting the borough by electricity, leaving the field open to private enterprise.

Accrington.—Mr. J. N. Shoolbred has been called in as consulting engineer to the borough of Accrington, with reference to the recent decision to proceed with the establishment of a central electric light station.

Helsingfors.—The house in which the Finnish Diet meets at Helsingfors has been completed. It stands in a central position, and is furnished with the electric light, and a very complete system of warming apparatus.

Variation of Earth's Magnetism.—With reference to our note on the mistake of the Admiralty in giving the magnetic variation at Liverpool as 9deg. instead of 8deg., it is pointed out that there seems a still greater error of "degrees" instead of minutes.

Sims-Edison Electric Torpedo.—It is stated on good authority that a company will shortly be brought out in London under the name of the Sims-Edison Electric Torpedo Company, with a capital of £200,000, to exploit the dirigible torpedo, which was lately tested with great success at Havre.

Electric Arms Syndicate.—An application was made on Wednesday to wind up the Electric Arms and Ammunition Syndicate on the ground that the real object had failed, and that the company intended to apply its funds to other purposes. The matter was ordered to stand over for a fortnight.

Factory Lighting in Germany.—The benefits derived from employing the electric light in the factories of Germany are said to have been so marked that a proposal is stated to have been brought forward to make the use of it compulsory in all factories where artificial light is employed during working hours.

Mauritius and Zanzibar Cable.—The Council of the Government of the Mauritius has voted the sum required to lay down a telegraph cable from that island to Zanzibar. This will be an immense advantage to the shipping trade, as messages to and from the Mauritius at present occupy 10 days to a fortnight in transmission.

Falmouth.—At Falmouth Town Council a letter was read with reference to the proposed public lighting of the town by the electric light, and Mr. Bullmore proposed, and Mr. Pearce seconded, that the matter should be referred to the Lighting Committee to confer with the same committee of the Local Board of the parish, and report to the Council.

Coventry.—The Electric Lighting Committee of the Coventry Town Council are considering the question of the immediate introduction of the electric light. At the last meeting Mr. A. Bromley Holmes attended and was consulted as to the best means of carrying out the provisional order, and undertook to draw up and submit a report thereon.

Roundhay Electric Tramway.—Mr. Graff Baker writing to the Leeds papers, states that it is a mistake to suppose that it is the Thomson-Houston Company who is equipping the line. He is doing it upon his own account, buying the apparatus from that company. Unless anything unforeseen occurs he expects to have the line running within a fortnight.

Sheerness Naval Barracks.—The Admiralty have under consideration proposals for lighting Sheerness Royal Naval Barracks with the electric light. An estimate has been forwarded of the cost, together with estimates of the expense of several other improvements in the establishment, which is about to be converted into a school of gunnery for the eastern ports.

Penryn.—At a meeting of the Penryn Town Council last Friday, the Mayor (Mr. John Bisson) presiding, Mr. R. A. Newcombe brought forward the matter of having the main street of the borough lighted with large incandescent lamps, one at the junction of the roads above the Town Hall, and one below. The subject is to be considered at a future meeting.

Mansion Lighting.—Messrs. Drake and Gorham are engaged in introducing the electric light into the Duke of Northumberland's town residence, Grosvenor-place. It will be remembered that this firm carried out the lighting of Alnwick Castle. The same firm has also the contract for lighting electrically the new offices of the Weights and Measures Department of the Government.

Vaughan-Sherrin Batteries.—Mr. Vaughan-Sherrin has left his previous temporary premises at Eagle Wharf, City-road, and taken a workshop at 37, Tabernacle-street, where we understand he intends to apply his battery to the driving of electric tricycles, bathchairs, and boats. It will be interesting to have particulars of the cost of these from some client after, say, six months' or a year's running.

Omnibus Lighting. — The expense of lighting 60 omnibuses in London recently by electricity for a period of 12 months was borne by the contractor who, for years, has illuminated nearly all the omnibuses in the metropolis by means of oil lamps. Since the experiment was made the system has been thoroughly reorganised, and the public will shortly find it working in most, if not all, of these vehicles.

Discovery of Mica Deposits.—The Under Secretary for Mines of Queensland received a telegram on August 25th from Commissioner Zilan, of Herberton, stating that a discovery has been made of mica in large quantities at a point about 25 miles west of Muldiva. The plates, he says, are of fairly good quality, are improving as the development proceeds, and are free from impurities. Four leases have been applied for, comprising an area of 100 acres.

Church Lighting at Deptford.—The London Electric Supply Corporation, who have gratuitously supplied St. Nicholas's Church, Deptford, with the electric light for the last three years, have given notice that they can no longer do so unless the arc lamps are substituted for the incandescent system. As the electric light has been found preferable to gas in many ways, the churchwardens have resolved to make the change, at a cost of 100 guineas.

Empress of Austria's Palace.—The castle being built for the Empress of Austria on the island of Corfu is approaching completion. It has received the name of "Achilleion," and stands in a most beautiful situation, with a view of unparaleled beauty, consisting of lovely valleys and olive-coloured hills, with the blue sea and the Albanian mountains for a background. The whole of the building and the splendid park will be lighted by electricity.

Electric Mining.—The annual meeting of the Federated Institution of Mining Engineers was held this year at Mason College, Birmingham. During the proceedings, Captain Harrison alluded to progress in methods of coal-getting during the coming year, and said that the direction in which he believed that most advance might be made was the application of electricity to haulage, coal-cutting, pumping, and other processes—a statement that was received with applause.

Utilising the Rhine.—A syndicate of Swiss and English capitalists, it is stated, has been formed to utilise a part of the Rhine Falls at Lauffenburg for the generation of electric energy. The water will be led off to turbines by races of ¾ mile long, and will yield a total of 7,000 h.p. The company will probably blast away the rocks which interrupt the course of the river at the origin of the proposed canal, a proceeding which will have a very favourable effect upon the navigation of the Rhine.

A Meteorological Phenomenon.—A remarkable meteorological phenomenon has occurred at Liarba, on the Tunisian coast. The sea, when at high tide, suddenly receded, and several small whirlwinds formed in the roadstead. One of these travelled along the coast, tearing up by the roots a number of huge trees. No houses were damaged, nor is any accident to life or limb reported. It is not known where the whirlwind subsided. The phenomenon was attended by violent electrical discharges.

Electric Tramcar Syndicate.—Mr. Jarman has now two complete tramcars in readiness and in working order. All Mr. Jarman's improvements and inventions are used. The cars are usual size, fitted with double motor capable of a maximum of 14 h.p., the weight being 5½ tons, including 106 cells (Jarman's). The maximum speed is 16 miles; the normal speed eight miles an hour. The car is lighted by electricity. The syndicate are now considering several contracts, amongst others for cars at Croydon.

Failure.—A receiving order having been made against Charles James Allport, described as an electrical engineer, of Woburn-place, Russell-square, the debtor has submitted a statement of his affairs showing unsecured liabilities £14,880, with assets £43. From the observations of the Official Receiver it appears that the debtor commenced business in 1882 with about £200 borrowed money, and attributes his insolvency mainly to losses in connection with mines. About £14,460 is in respect to money borrowed.

London County Council.—The Highways Committee of the London County Council having had authority to deal during the vacation with such matters as might arise, have reported at the meeting on Tuesday that they have sanctioned the following work: Notting Hill Electric Light Company to lay mains in Chepstow-place, Pembridge-square, and Pembridge villas; the Knightsbridge Company for mains in Queen's Gate; the Vestry of St. Pancras, for mains in Euston-road, Tottenham Court-road, and High-street, Camden Town.

Dover and Deal Telephones.—Wayleaves are now being obtained for the erection of a new trunk line from Dover to Deal direct. This addition will do away with the great inconvenience and delay caused to the subscribers at Dover, Deal, Sandwich, Ramsgate, and Margate, through the necessary switchings at Canterbury, and the new wire will be a long-needed improvement. The preliminary arrangements are being rapidly pushed on, and Mr. Burden, the National Company's district manager, hopes to have it ready for use by Christmas.

Bandsept Accumulator.—A new type of storage battery invented by M. Bandsept is being introduced by the Compagnie Franco-Belge d'Appareillage Electrique. The plates are formed of a powder agglomerated by pressure and saturated by a substance volatilised by the pressure. The elements may be equally employed for primary or for secondary batteries. After a series of very encouraging trials the Compagnie Franco-Belge have decided, says the *Bulletin International*, to employ these accumulators for the lighting of the Brussels tramways.

Hawaiian Tramways.—At the fourth general meeting of the Hawaiian Tramways Company on Monday at the City Terminus Hotel, the chairman, Colonel C. M. Davidson, stated that with a view to the future an Act had been obtained from the Hawaiian Government giving the company power to use electricity, which was expected to prove of great advantage to them. At present their horsing cost them 4·46d. a mile, and if they could lessen that cost it would be a great gain. The London office of the company is 301, Camberwell-road.

Portsmouth.—Some hitch, it is stated, has arisen with the proposed introduction of the electric light into the borough of Portsmouth by the Corporation, and the committee has resolved to recommend that the appointment of Mr. J. N. Shoolbred as consulting engineer for the installation be deferred in order that further particulars as to the financial working of the scheme should be obtained. Prof. Garnett, of the Technical Education College, Durham, has been invited to furnish a report, and until this has been received no further action will be taken.

Liverpool Inspector of Electric Lighting.—Mr. C. H. Yeaman, who for the past two years has had entire charge of the electric lighting department of the Corporation, has been appointed engineer of the British Insulated Wire Company, Prescot. The Watch Committee advertised the vacancy thus created, and there were 51 applications for the position, the salary attached to which is £160 per annum. On Monday the committee appointed Mr. John Carlton Sherman, of Liverpool, who was educated at University College, and for two or three months has acted as expert assistant to Mr. Yeaman.

Electricity at Poona.—At the annual Soldiers' Exhibition recently opened at Poona, says the *Daily News*, there is a remarkably clever model of a stationary steam engine, made in India by a British private. Limited as his resources must have been, the result is an exquisitely finished and marvellously accurate piece of work. Another of the exhibits is the invention of an officer—a small electric punkah for hanging inside mosquito curtains. Attached to it is a small clock and an electric light. A sowar of the 2nd Bombay Cavalry contributes some standard lamps of bent brass, constructed on English models, which are of excellent workmanship.

Lightning as an Explosive.—A story comes from Australia of a strange freak of lightning. It appears that a telegraph line was being erected some years ago, and at a certain point the line went over ironstone rock. Holes were dug in the solid rock for the poles. It had rained, and the holes contained some water; one of the telegraph poles had just been fixed in above the water. A storm came on, and the men went into shelter. A flash of lightning struck the pole, and the pole was shot 60ft. into the air by the explosion. The story would be more true—or at any rate more interesting—if the pole had come down again exactly in the same hole.

Chatham.—At the meeting of the Chatham Town Council last week a communication was received from the secretary to the electric lighting company as to the proposal to light the Council-chamber, and upon the motion of Councillor Smith, seconded by Councillor Burrell, the surveyor was instructed to have an interview with the engineer of the company and report to the Council. Councillor Burrell expressed a hope that the whole of the town and the establishments would, ere long, be illuminated with the electric light. He thought the company would be in a position to supply abundant light when their new works at Chatham were erected.

Paddington.—The first step towards the public lighting of Paddington is the lighting of the Town Hall. This will be completed in this week or next; when finished, street lighting will probably be proceeded with at once. The Town Hall lighting consists of 120 incandescent lamps. The contractor is Mr. Conolly, and the fittings, etc., are very handsome and massive, one chandelier in the large hall for 24 lamps being particularly fine. The current is to be supplied by the Metropolitan Electric Supply Company, who have a 40 years' contract. They hope to erect a station soon in the vicinity. Current to the Town Hall will probably be laid on in the course of this week.

The Electric Lighting of Studley Royal.—The work of illuminating Studley Royal, the Yorkshire seat of the Marquis of Ripon, with the electric light has just been successfully completed under Mr. S. Harrison, engineer, by Woodhouse and Rawson, Limited. A 10-hours' trial at full load was made of the turbine and dynamo, which yielded energy for 300 lights without being overtaxed. Within the hall a soft, full light was obtained, the superiority of electric lighting in handiness, cleanliness, purity, and ornament being apparent. The facility with which the energy required is developed by water power is a guarantee that this mode of illumination is much cheaper than by any other means.

Popular Electric Lighting.—A new and interesting addition to electrical works will be published early in October, entitled "Popular Electric Lighting: Practical Hints to Present and Intending Users of Electric Energy for Illuminating," by Captain E. Ironside Bax, general manager of the Westminster Electric Supply Corporation. It will be published by Biggs and Co., and the price will be 2s. Besides a glossary of terms, the work will deal with the duties and rights of supply companies, information upon wiring and contracts, the description of meters and their use, and an explanation in straightforward and practical style for householders of necessary information as to lamps, candle-power, cost of lighting, specimen estimates, and a complete list of suppiy companies. A chapter on the use of motors will also be given.

Electric Lights Wanted.—On Thursday last week Mr. William Hudnot, of the Electric Launch Works, Strand-on-the-Green, Chiswick, was summoned to the Kingston-on-Thames County Bench for having, on the 14th August, whilst in charge of the electric launch "Pilot," on the Thames, near Teddington, navigated the same after sunset without exhibiting the lights, as ordered by the Thames Lights By-laws, 1888, and he was further summoned for a similar offence off Molesey on the same day. Mr. Bunting, solicitor, prosecuted on behalf of the Thames Conservators. It was explained that the electrical apparatus got out of order, with the result that the speed of the craft was considerably diminished, and night came on before he was more than half way to his destination. The defendant was ordered to pay a fine of £1, including costs.

Manchester.—The Manchester Corporation are about to lay down one or more installations for the supply of electricity, and in order to facilitate the arrangements and to guide the committee as to the extent and position of the stations and as to the power of the engines, dynamos, and other machinery and plant necessary, advertisements have been inserted asking persons or firms who are likely to require a supply of electricity within the prescribed area to communicate in writing with the committee to that effect. Mains will in the first instance be laid down in the following streets—viz.: Deansgate (from King-street to St. Mary's Gate), St. Mary's Gate, Market-street, Piccadilly (from Market-street to Mosley-street), Mosley-street (from Piccadilly to York-street), York-street, Spring-gardens (from Market-street to King-street), King-street (from Spring-gardens to Deansgate), Cross-street (from King-street to Market-street).

Middlesbrough.—On Wednesday a meeting was held of the Middlesbrough General Purposes Committee of the Corporation, Alderman Archibald presiding. A deputation was received from the Middlesbrough Electric Lighting Company to give any information that might be desired with regard to the proposal of supplying Middlesbrough with the electric light. Mr. Sellon, assistant manager of the Middlesbrough Electric Lighting Company, explained the leading features of the provisional order for which the company were applying. He stated that the price the company would probably charge for the use of the electric light would be 60 per cent. more than the cost of gas. He said, in conclusion, that the Middlesbrough Electric Supply Company was backed up by the Brush Electric Lighting Company, and that would be a guarantee of the success of the undertaking. It was subsequently decided that the whole matter should be referred to a sub-committee.

Atmospheric Electricity. — The most important recent experiment regarding atmospheric electricity, carried out at the Blue Hill Observatory by Mr. Alexander McAdie, seems to take one back to the very infancy of electrical science; for, though the conditions were somewhat different, the operation was substantially identical with Benjamin Franklin's historical experiment with the kite. What Mr. McAdie has demonstrated is that electricity can be drawn from a kite high in the air in a cloudless sky. The kite, Mr. McAdie states, discharged sparks from the lower end of an insulating wire reaching down to the earth, where an electrometer partly measured the increasing electric force. So nearly did the quantity of electricity in the upper air correspond to the height of the kite above the earth that the experimenter could usually determine whether the kite was rising or falling by simply looking at the needle of the electrometer.

Lightning Casualties.—Some interesting figures have been collected by the German Ministerial Department with regard to lightning casualties during 1877-1886, in buildings under their jurisdiction. Out of 53,502 buildings, 264 were struck in 10 years, or 5 per 1,000 per 10 years. Some curious averages came out; elementary schools were struck ·8 per 1,000, churches 8·2, colleges 15·4, universities 24·1, private houses 44·9, and horse-breeding establishments 312·5, from which it might possibly be inferred that the vapour of ammonia rising from these latter were a factor in the case. Out of the 264, only 81, or not one-third, resulted in a fire. Of the total number struck, 15 were protected with conductors, but only one escaped injury; in five of these the conductors were useless, and in six were inadequate. The damage was comparatively small—£215 per casualty, or 2s. per building per year; two-thirds of this was in the horse-breeding establishments. The danger from lightning is said to have increased threefold in Germany within the last 30 years. The average loss per year throughout Germany is given as £300,000 to £400,000.

Dundee.—The Electric Lighting Committee reported to the Dundee Gas Commissioners at their meeting on Monday that in their opinion the first thing to do was to appoint an engineer, as his advice might be useful in the matter of selecting a site for an electrical station; and they further stated that, having considered the applications and the qualifications of all the parties, they unanimously recommended that Messrs. Urquhart and Small, Westminster, should be appointed. Mr. Urquhart had had great experience in electrical engineering, and Mr. Small in mechanical engineering. Besides this, Mr. Small was a native of the city, and they thought, therefore, that he had an advantage, as his local knowledge would be of the greatest advantage to the Commissioners. The committee recommended the firm on the condition that their plans and specifications be submitted to some electrical engineers of the highest standing for their consideration and revisal before any tenders were advertised for. At a public meeting held immediately after, ex-Provost Brownlee moved that Messrs. Urquhart and Small be appointed. Lord Provost Mathewson seconded, and the motion was unanimously agreed to. The works, which are to cost about £20,000, are to be proceeded with at once.

Bombay.—The proposal to experiment with the electric light in certain parts of the cantonment of Poona, though at first scouted as being much too expensive, still hangs fire, says the *Times of India*. Mr. E. O. Walker's latest proposal, together with a minute thereon by Major E. D. Newnham-Smith, the secretary to the Cantonment Committee, were submitted to Mr. Rienzi Walton, the executive engineer of the Bombay Municipality, who was asked to state his opinion thereon. Mr. Walton's letter in reply was placed before the members of the Poona Cantonment Committee at their meeting on September 8, Major-General Blundell being in the chair. Mr. Rienzi Walton was of opinion that Mr. Walker's offer to the Cantonment Committee was a very advantageous one, for it offered to replace the 575 kerosene oil lamps of 9½ c.p. each with electric lights of 16 c.p. each, the cost of lighting in each case being 1·02 rupee per lamp per month. If the experiment is at all made in Poona, the wires will have to be overhead and not underground. The whole question has now been referred to a sub-committee, consisting of Major H. W. Duperier, R.E., executive engineer; Mr. E. O. Walker, C.I.E., superintendent of telegraphs (who have given the Cantonment Committee much valuable assistance in drawing up a scheme), and Mr. Rajana Lingoo, pleader.

Telephonic Facilities on the South Coast.—The directors of the Western Counties and South Wales Telephone Company, with a view of offering every facility to their subscribers, and thereby making the Bournemouth telephone system not only as complete and comprehensive as possible, but also popularising it in every way, thus making it still more useful to their subscribers, have, upon the recommendation of their general manager, decided to include Parkstone within the district of Bournemouth, in the same manner as they have recently treated Boscombe. The company's subscribers to the exchange system in Bournemouth or Boscombe may now, therefore, upon presentation of their blue leather call-room pass, or lady members of subscribers' families upon presentation of the white leather pass issued to them, when at Parkstone speak to the Bournemouth or Boscombe subscribers free of charge. A similar privilege in respect to the Parkstone call office is also extended to Poole subscribers. The directors have also decided to keep their exchange open later and to open earlier. The present number of subscribers to the local exchange is 340, the average calls per day 1,100, and at night 45. The following towns are in telephonic communication with Bournemouth: Poole, Christchurch, Southampton, Winchester, Fareham, Gosport, and Portsmouth.

Anglo-German Cable.—On Friday the new cable, which has just been successfully laid by the Post Office authorities between England and Germany, was practically tested, being for the first time utilised in the transmission of public messages. The cable starts from Becton, on the Norfolk coast, not far from North Walsham, and goes by way of Borckum to Emden. It contains four wires, the disposition of which is not finally settled. It is probable that the services to Berlin, Hamburg, and Frankfort-on-Maine will be increased respectively by one wire, and that the fourth will be given to Vienna, with which centre direct communication has for some time been open *viâ* the German capital. An alternative of this arrangement would be to make Magdeburg a centre, and thus to relieve the pressure on the Berlin circuits. The important increase of telegraphic traffic between this country and Germany and Austria-Hungary since the assumption by the Post Office of the entire control of the working, and the subsequent reduction of the tariff, has made the new cable an urgent necessity. The relief, however, will not be felt immediately, as one of the Belgian cables broke down almost simultaneously with the opening of the new one. When this is re-established, the effect of the extended means of communication should be at once seen in the reduction of the delay in the transmission of messages between the two countries.

Electric Mining.—During the recent visit of the members of the Mining Institute of Cornwall to the Continent, one of the most important visits was that made to the Mechernich lead mine in Brussels. The mine is lighted by electricity. The pumping engines at the hollow of the mine burn 2·1 kilogrammes of coal per horse-power, as compared with four kilogrammes consumed by the well-known Cornish engines they formerly employed. The enormous quantity of stuff raised daily surprised the visitors. This is over 3,000 tons daily, and is treated by 25 hands only, so perfect are the automatic arrangements. One particular portion of the working is worthy the attention of colliery managers at home. When a waggon of ore is tipped at the shaft's mouth, electric contact is made in the tipping, and a small needle in the office makes a red mark on a band of paper revolving by clockwork. The object of this is not so much to give automatically the number of waggons tipped as to show at a glance that hauling is proceeding regularly. The paper band is divided in half hours for a week throughout; and at the end of the week's work it is seen at once the number of waggons that have been tipped on any day or at any time. It is thought that if this system were adopted at home it would lessen the disputes that arise as to amounts raised, which still occur in spite of the special tallyman.

Compressed Air and Electricity.—The town of Lucerne, it would seem, after having had four years' experience of alternating-current distribution of light by Ganz and Co., is going to supplement this by a distribution of force from the same water power; but this will be carried out, according to arrangements made with Messrs. Riedinger, of Augsburg, by means of compressed air. It may be interesting to mention in connection with this event, that the town of Offenbach has lately received a very complete installation of compressed air distribution, which seems to be causing great interest amongst German engineers, as being the first application of compressed air in Germany. Technical engineers are constantly arriving to study the working of the station. An engine of 300 h.p. is used as generator. The station, which is situated on the banks of the Maine, is remarkable on account of the absence of belts or apparatus. The air pumps are constructed with their piston rods in direct communication with the steam-cylinders, so that direct transformation of force takes place. The company undertake electric lighting, and have a sub-station in the centre of the town; another sub-station is under consideration on account of the numerous applications for light. The electric part of the installation has been carried out by Messrs. Schuckert and Co. The air from the compressed air engines is extensively used for cooling in the hotels.

London Electric Supply Company.—This company have now recovered from the disastrous effects of their fire, and extraordinary precautions have been taken in the substations to secure perfect safety. The buildings are all perfectly fireproof, and built in the most approved fashion. Running was started, it may be remembered, in March last, with 10,000 lamps, and the supply has been kept on continuously since without the least mishap until the present time, when thirty-five thousand lamps are on. As the company can supply 90,000 lamps, there is therefore a large reserve power at the Deptford station. The plant in use consists of two 1,250-h.p. dynamos, each capable of maintaining 30,000 lights, and two 750-h.p. machines, each for 15,000 lamps. Thus, with 35,000 lamps running, and plant for 90,000, the reserve is ample. Moreover, there are now four mains the whole way to the City, and as one only is amply sufficient for safety, the risk of breakdown or accident is practically entirely obviated. The new large dynamos in progress will not be erected and completed till there is need for increased power by the demand exceeding the present supply, and each of these new dynamos will be alone capable of maintaining 90,000 lamps. There are at present three principal substations—Trafalgar-square, New Bond-street, and one now in progress at Pimlico. Mains are also being carried south of the river. The success at Frankfort, Antwerp, and other places of the high-tension system has largely increased the confidence of the public; has, in fact, demonstrated its value as the only practical system for large supply from a distant generating point. With this, and also the immense precautions taken and faultless running of last few months, prospects are very encouraging, and large business is confidently expected.

Cost of Gas and Electricity.—The popular mind is quite sufficiently alive to the extra cost of electricity over gas to need no further frightening by scribes who are speaking without book. The *Newcastle Daily Chronicle*, speaking of the Duke of Marlborough's home truths in his recent speech as chairman of the Brush Company, remarks: "The fact is the electric light is, as yet, a somewhat expensive luxury, which the enterprising tradesman and those who deal with delicate goods may find it advantageous to adopt, but which for general purposes cannot compete with gas in the matter of cost, and probably never will be able to do so until it is produced by a different method." To the first part of the sentence we have little to object; it is always true (and well it should be so) that the richer householder and shopkeeper should first take the electric light instead of gas. The latter part we entirely deny. There is not the slightest need for consumers to consider they must wait until "different methods" of producing electricity are invented for the electric light to be as cheap as gas. All that is necessary is to wait until the supply can be given on equal scale to that of gas. Even now the cost to many private consumers is but little in excess, year by year, of that of their previous gas bills. Experience in the low-tension accumulator system in the London companies over two years has given proof in actual cases that the comparative cost is very closely given as one-quarter more than gas at 3s. per 1,000 cubic feet—consumers paying £30 a year for gas, candles, tapers, and matches, having been found to pay £37 a year in all for their electricity. It needs but little foresight to believe that if such cases can be brought forward even now, that when the whole of a large plant is in full working order, and time reduces the charge for current, that electric light can be obtained for yearly amounts equal to that of gas without recourse to wonderful inventions in the future.

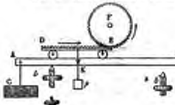
Preston.—At the monthly meeting of the Preston Town Council, last week, the committee recommended that Fishergate, from the railway station, and Church-street, to opposite Lancaster-road, be lighted by electricity by the National Electric Supply Company, Limited, as an experiment, for a period of three years, on the terms set forth in the company's solicitors' letter—viz., to fix 10 arc lamps, each of 500 c.p., in Fishergate, and run the same from sunset to sunrise, at an annual charge of £156. 5s., with the following condition: That if the consumption was reduced from 4,000 hours to 3,000 by alternative lamps, to the number of one-half, being extinguished at midnight, the annual charge named in the letter should be reduced by £30, to permit of which the installation will be on two circuits. That to avoid shadow the company will increase the number of lamps by one or two, and the company guarantee by duplicate plant against unsteadiness or the going out of the light, and, periodically, satisfactorily to verify the illuminating power at their own cost, the company to maintain the lamps and the Corporation to only provide and fix the standards. Any further extension for public lighting that the Corporation may subsequently desire to be done by the company after the rate, per set of 10 additional lamps, of not more than the aforementioned terms in their letter as amended in the aforementioned conference. The terms to be embodied in an agreement to be prepared by the town clerk. Alderman Satterthwaite, in moving the adoption of the report, stated that last year the National Company obtained powers to light Fishergate, and now contemplated putting their wires underground, when they found out how much light was required. The present lighting cost £100, plus £17 for cleaning and lighting, giving about 1,000 c.p.; the electric light gave them 5,000 c.p. for £126 a year. The expense of 10 new brackets would be about £25. The motion having been seconded, Alderman Davies said he had been at some trouble to go into this matter, and he found that at present Preston was not only the worst-lighted town in Lancashire, but the worst-lighted town in England. He should support the resolution, for a town well lighted was half watched. After some further discussion the motion was carried.

THE MARES ELECTRIC METER.*

The Marès meter, to which the prize of 1,000f. has been awarded for the measurement of continuous currents by the Paris Commission, is a discontinuous integrating wattmeter. The registration takes place every four minutes upon dials whose hands mark hecto-watts. As regards exactitude of measurement of the energy consumed, this meter is found quite as satisfactory as the continuous integrating meters, nor is it more liable to fraud, as the intervals between registrations are so small.

The instrument is comprised of a wattmeter based on the principle of electro-dynamic balances, of a stopped clock, and of registering gear and dials.

Fig. 1.—Diagram of Marès' Meter.



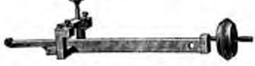


Fig. 2.—Oscillating Beam.

The diagram, Fig. 1, shows the principle of the working of the Marès meter. A B represents the beam of a balance carrying at H the coil, G, of the wattmeter, which is shifted downwards when traversed by a current. The attractive force exercised upon this coil is always proportional to the electric energy expended, which is the measure required. To obtain this result a weight, *p*, is hung on the beam by a movable carriage, D E.

The system is in equilibrium upon the knife-edge, K, when current is not passing, and when the carriage is at zero point. If, on the other hand, the coil, G, is attracted by the current, the carriage is shifted an amount proportional to the force of attraction to re-establish the balance. When such displacement occurs, the cogwheel arrangement upon the upper part of the carriage gears with the wheel, F, of the counter dials as long as the arm, A B, remains horizontal and rests upon the stud, *b*. When the equilibrium is upset, the lever, A B, swings over and rests upon the other stud, *b'*, and the gearing between D E and F ceases.

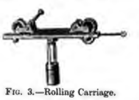


Fig. 3.—Rolling Carriage.

By means of clockwork, which is described further on, the carriage is driven by a to-and-fro movement of an amplitude equal to its length, and as the arm is regulated to tip over when the centre of gravity of the carriage does not coincide with the point of suspension, K, it follows that the distance traversed by the limb of the wheel, F, is equal to the distance that the weight has to move from the point of equilibrium to balance the force of attraction at the precise moment that the beam tips over.

During the four minutes that each period of integration endures, it is supposed that the current strength remains constant: a registering apparatus adds up finally the total energy expended in function of the time—that is, in watt-hours.

The actual arrangement of the balance-beam is shown in Fig. 2: one of its extremities carries the fine wire coil of the wattmeter, and the other a counterweight regulated by a screw. This beam is suspended upon two steel screw points, working in steel slots. A piece of brass placed above these pivots, adjustable by means of a screw, allows the balance to be made more or less delicate.

The wattmeter is somewhat similar to Sir William Thomson's balance. The flat horizontal coil of fine wire is mounted in shunt on the main circuit, and placed between two coils of thick wire or copper ribbon, according to conditions, traversed by the total current to be measured. The space between them is just sufficient to allow the small coil to oscillate. The resistance of this latter is 5,000 ohms

The carriage, Fig. 3, rolling upon two runners carried by the beam thus receives in the manner before described a periodical displacement to and fro by means of a clockwork

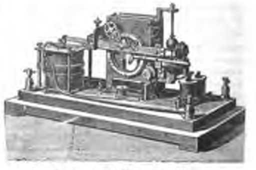


Fig. 4.—Marès' Meter—Back View.

movement, having "Lahire" gearing. The pinion of this gearing is connected to a slot moved horizontally, upon which is attached a very light arm fixed to the carriage, the course of which is thus rendered equal to the diameter of the prime circle of the interior wheel, the result of a well-known theorem. On the other hand, the cogwheel gearing of the carriage gears with the first wheel of the meter, or escapes therefrom according to the movement of the beam.

The clock movement is provided with a conical pendulum, making 120 revolutions a minute, and driven by a train of wheels brought into play by a motor spring, whose

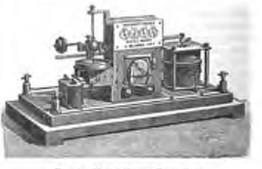


Fig. 5.—Marès' Meter—Front View.

ratchet-wheel is seen, Fig. 4, in the centre of the cover-plate.

The clock is kept wound by an electric winding-up arrangement, acting when the meter is not integrating. For this purpose an electromagnet of 1,000 ohms resistance, fixed to the cover-plate, acts upon an arm which comes forward and engages in the teeth of the ratchet. At each passage of the current into this magnet, this arm comes down and winds up the spring by one tooth. At the breaking of the current, a coiled spring draws up this arm, which then engages another tooth. To keep the movement going, all that is necessary is at each reading to wind up the spring the number of teeth it is run down For this purpose a circular switch, making one revolution for each excursion of the carriage, presents five contacts to the touch of a spring, which has the effect of sending the current five times into the winding-up magnet. The main spring is thus wound up five teeth, and if it run down exactly the same amount its tension remains constant.

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* Translated from the *Revue Industrielle*.

The same switch sends the current into the fine wire coil during a *half revolution*, corresponding to the period of measurement. If the current were to be in this coil when the carriage passed by the point by which it had left the totaliser wheel, it would be raised, and the wheel would return backward the distance it had advanced. By means of the interruption of the current this effect cannot occur; but when the carriage arrives at the origin point of a new measurement, the current is sent into the coil and the beam is raised. As all these currents are very weak, the sparking is negligible; they are avoided, moreover, by the precaution of having a small shunt coil.

It remains now to describe the special arrangement adopted to carry out the stopping and starting of the clockwork; if this clockwork is not disengaged when the current is broken, the main-spring would run down completely, and the meter would not again act when the current passed.

To maintain the spring at a uniform tension, an electromagnet is placed alongside the pendulum, the armature of which disengages or stops the conducting arm of this pendulum. As soon as the current is broken this armature falls and stops the clock; when the current again passes, the armature is drawn up and the clock starts.

The current to be measured enters at the thick wire coil and leaves by the other end of the meter; this other end is connected to a shunt wire to the return wire.

This meter must be carefully placed in a horizontal position, and adjusting screws are everywhere arranged so that the position of the various parts may be adjusted to suit the position.

The regulation of the integration is a very important operation, and one of the simplest. Taking a meter for a maximum of 1,500 watts, as the straight cogwheel gearing has always 100 teeth, the gearing of its whole length will register this quantity. The readings being taken at the number of 15 an hour, the totaliser needle should mark a hecto-watt for each, and at the end of the hour 15 hecto-watt hours. Each tooth of the straight gearing or of the first meter wheel thus represents 15 watts.

To regulate the meter, a current is passed as near as possible to the maximum to reduce errors. If we take the figure 1,200 watts, the meter wheel should gear with the 1,200 ÷ 15 teeth of the cogwheel—that is, with 80 teeth—and the beam should tip over after the 80th tooth is passed. In order to avoid trials, the cogwheel is pushed by hand to the 80th tooth, pressing upon the beam to raise it; then after having stopped the clockwork, the little bucket below the carriage is filled with lead shot until it balances. This shot is rendered adherent by a little melted wax.

The Marès meter is extremely practical: particular care has been taken with all the contacts; they are all friction contacts; their springs are powerful, to avoid missfires. The forces brought into play are always identical to themselves, and as the operation is brought about by balancing, definite precision of measurement is obtained.

M. Marès is to be congratulated the more on the success of his instrument in that he constructed the first models himself. He has studied one by one all the details with M. Déjardin, a clever constructor of instruments of precision, and this collaboration has resulted in a solid and delicate instrument, of regular action and great exactitude.

THE LŒVENBRUCK ARC LAMP.

There are at the present time some 2,000 arc lamps, the subject of as many different patents. The number of these in practical use is relatively small. This fact may be explained by various reasons, the principal being the difficulty of successfully introducing on the market a lamp similar to others already well known, or of realising an arrangement of parts sufficiently simple and perfect to offer advantages of economy over those at present in use.

Perfection of working, as well as lowness of price, have often been claimed by inventors of arc lamps; nevertheless, up to the present the means have apparently not been found to unite these two conditions satisfactorily, and the most satisfactory lamps are always those presenting a considerable complexity of interior arrangement, and these cannot, consequently, be sold at the low price naturally sought.

Can it be said that with regard to arc lamps, this desideratum of simplicity and cheapness can never be reached? This is not the opinion of M. A. Michaut, who, writing in *L'Electricien*, describes a new and considerable step in advance made by M. Lœvenbruck in his new arc lamp. The lamp which this inventor has recently introduced is simple, solid, and its construction is really economic. It has already been well tested in actual practice.

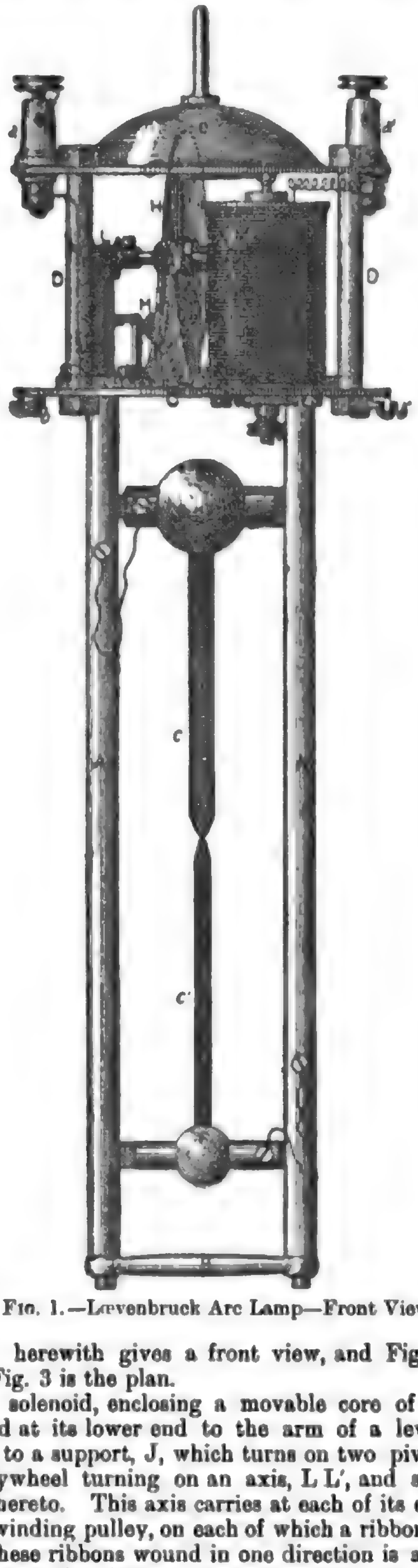


Fig. 1.—Lœvenbruck Arc Lamp—Front View.

Fig. 1 herewith gives a front view, and Fig. 2 a side view. Fig. 3 is the plan.

G is a solenoid, enclosing a movable core of soft iron, connected at its lower end to the arm of a lever solidly soldered to a support, J, which turns on two pivots, K K'. H is a flywheel turning on an axis, L L', and solidly connected thereto. This axis carries at each of its extremities a small winding pulley, on each of which a ribbon is wound. One of these ribbons wound in one direction is attached in the interior of a hollow copper stem, A, to the upper carbon-holder, E; the other, wound in the other direction, is fixed in the stem, A', to the bottom carbon-holder, F.

A flat spring, N, acting by the intermediary of a lever arm fixed to the support, J, of the flywheel to make this latter oscillate and make it come into contact with a regulating break, M, which limits its movement of the oscillating arm.

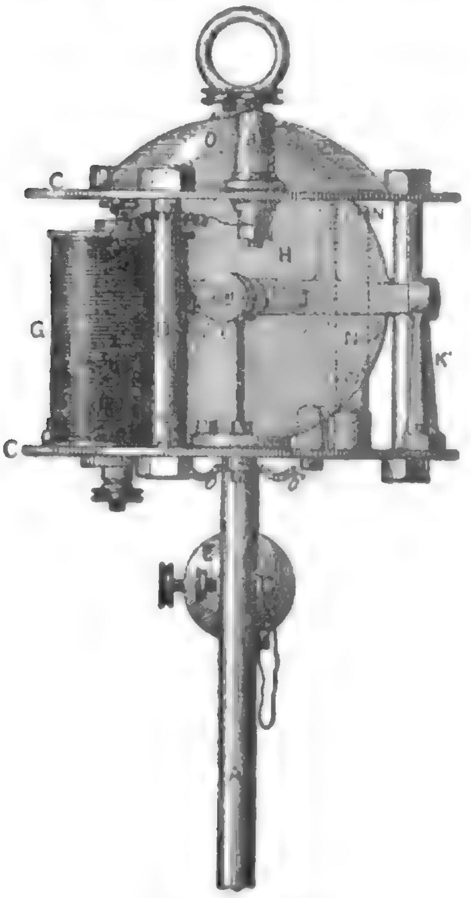


Fig. 2.—Side View.

These parts are arranged between two base-plates, C C, kept in position by three pillars, D D D, and are covered in when the lamp is in use by a cylindrical cover fastened by the hooks, *b b'*.

The carbon-holders, upper E and lower F, slide in the grooves of the two hollow stems, A and A', held in position at the upper end by the base-plate, C, and at the lower end by the cross-bar, B. The stem A is insulated from the latter, as well as from the lower carbon-holder and the frame, by pieces of vulcanised fibre or ebonite; it is connected to the lamp terminal, and a flexible wire assures its good connection with the upper carbon-holder. The stem A', insulated from the frame, is connected to the lower carbon-holder on the one hand, and to the solenoid, G, on the other, the winding of the latter ending directly at the other lamp terminal, *a'*. The frame of the lamp is thus completely separated from the electrical circuit.

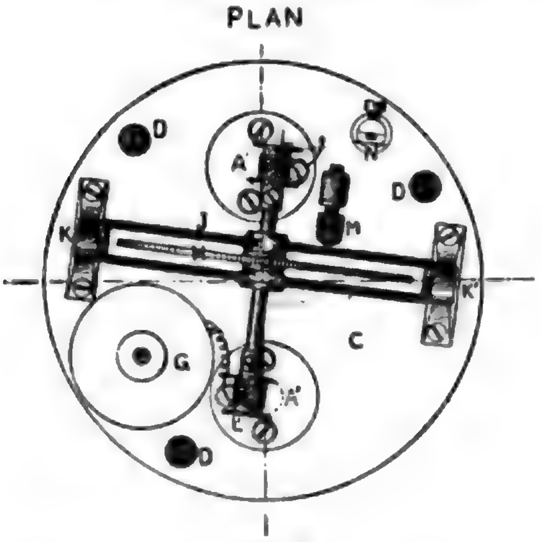


Fig. 3.

The apparatus described is sufficiently simple for its action to be easily understood. The diagram, Fig. 4, plainly shows the action of regulation, which is extremely simple. In the diagram the core, B, of the solenoid, S, is seen articulated, at its lower end on the carrier of the flywheel, but the contrary is seen in the Figs. 1, 2 and 3. There is also at D a counterweight, which has been done away with in the lamp as now constructed; the spring C, which is in reality a steel plate fixed vertically on the lower base-plate, is made stronger than is necessary, merely to compensate for the suppression of this counterbalance.

When not in use, the carbons are in contact by the effect of the weight of the upper carbon-holder. Arriving at lamp the current traverses the upper carbon, passes by the lower carbon, and passes out at the solenoid. At this instant the core, B, Fig. 4, is attracted, and makes the support, A, and the axle, X X', of the flywheel oscillate on its pivot, O; at the same time the flywheel presses against the brake, F: consequently, the carbons come slightly apart, and the arc is formed; all movement stops until the arc lengthens and the resistance increases. The current decreases, the action of the solenoid on the core, B, is less powerful, the spring, C, is allowed to act, and the flywheel pressing with less force against the brake, the axle, X X', turns, pulled round by the weight of the upper carbon-holder by means of the ribbon, M'. The lower carbon-holder, which is less heavy, is raised by its ribbon, M, wound in the contrary direction to the ribbon M'. The two carbons come together, the arc recovers its normal resistance, and the flywheel presses once more against the brake.

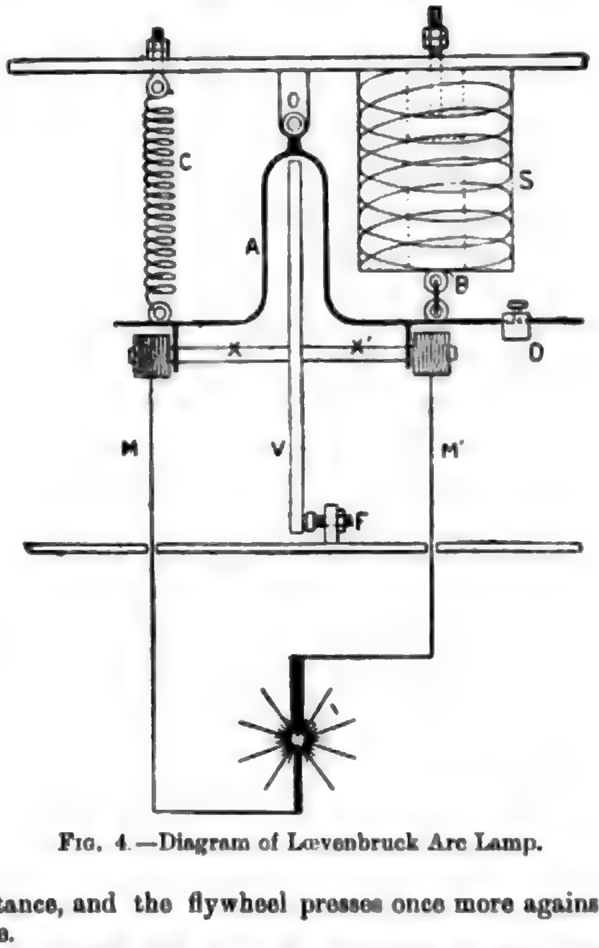


Fig. 4.—Diagram of Lœvenbruck Arc Lamp.

These actions take place by insensible degrees, without blinking, and occurring constantly until the carbons are burnt out. The proportional size of the carbons being properly chosen, the position of the arc remains constant.

This lamp, as above described, is intended to be mounted in shunt. To use it in series, it simply requires a differential winding. It will be noticed that the regulating parts are few and occupy a very small space. This not only allows the lamp to be cheaply constructed, but also gives the advantage of a very short lamp, a condition extremely favourable for decorative effects and restricted space.

Cost of Electric Light.—Cincinnati is said to be the only large town in America without electric lights. The cost of lighting per inhabitant by gas, 1889-90, was 3s. 1½d., while in towns lighted by electricity the average charge is 2s. 10½d. per head. It varies, however, greatly—from 1s. 5d in St. Lawrence (water power) to 4s. 9½d. in Los Angeles.

THE BARDON ARC LAMP.

The accompanying illustrations almost explain themselves. These lamps, it will be seen, are of two types. The first type, as in Fig. 1, shows a solenoid, B, wound with thick wire, in the interior of which are two cores—one end, N, being fixed, and the other, N¹, which is movable, the latter being held by a spring, R, and carrying at its upper part a connection, B, which passes through N, and actuates the lever, A, around the fulcrum, O, the lever forming the brake from the disc, V. An upper carbon is carried by one end of the cord of the pole, which passes around P P., as shown, the other end of which is fixed to the point, C, of a second lever moving around the fulcrum, o^1. When the circuit is open the cord, n^1, feels fully the effect of the spring, R, and the lever, A, does not brake the disc, so that the weight of the carbon causes it to fall. On the current going through the wires of the solenoid, however, the brake is applied. It will be seen that at the same time the brake is applied the extremity of the second lever is lowered, thus permitting the lower carbon to descend, and the arc is formed. As the resistance of the arc increases, the pole upon the core N¹ is lessened and the force of the spring asserts itself, allowing the action to be repeated. It will be seen that the arrangement is such that the length of advance of the upper carbon is double that of the lower.

FIG. 1.

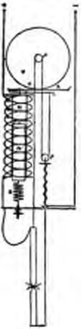


FIG. 2.

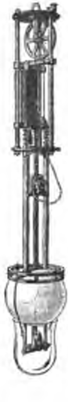


FIG. 3.

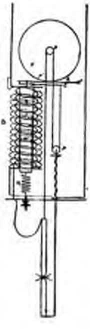


FIG. 4.

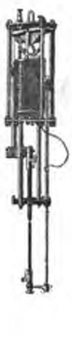


FIG. 5.

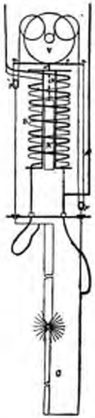
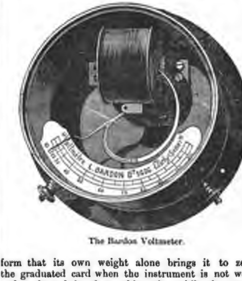


Fig. 3 shows another form of lamp, in which a smaller wire passes around the core of the differential action of the two wires, and determine the regulation of the arc. This system of differential winding maintains constant the relation between e and c, or what comes to the same thing, the resistance of the arc. The voltage required at the terminal of the lamps is from 58 to 60 volts. These lamps in practice have given good results, but M. Bardon desired to make still better, and modified the construction as shown in Fig. 5, where the solenoid, B, is placed in the centre of the lamp, and the cores, N, N¹, and the lever, poles, and cords placed as shown. Figs. 2 and 4 show complete lamps. It is said of this modified form of lamp that the feeding is absolutely continuous, but imperceptible to the eye.

THE BARDON VOLTMETER AND AMMETER.

A new voltmeter, lately introduced by M. Bardon, whose arc lamp we describe in another article, presents some points of extreme simplicity and accuracy of working. This instrument, shown in the illustration, has its pointer, which forms part of the movable core, constructed of such a form that its own weight alone brings it to zero on the graduated card when the instrument is not working, and tends to bring it to this point while the current is



The Bardon Voltmeter.

passing. It therefore belongs to the type of gravity measuring instruments, acting without the use of springs.

Its action is apparent from the illustration. A fine wire solenoid is mounted on a hollow bobbin inside a hollow brass case. At the centre of this solenoid a thin plate of soft iron curved in the form of a sickle forms one piece with a straight arm which acts as the pointer. The whole turns around an axis, the centre of a circle of which the soft iron core is an arc. The zero of the instrument is obtained from the state of equilibrium of the core; the pointer is adjustable by means of a small screw counterweight.

When current passes, the soft iron core is attracted into the solenoid, but because of its form, the greater its penetration the more the electromagnetic action upon it increases, so that the amplitudes cross equally. The spaces of graduation are thus sensibly equal—say, from 60 to 120 volts.

It will be seen that the action antagonistic to rotation increases as the centre of gravity is displaced more and more from the vertical line passing through the axis of rotation. This makes the instrument very dead-beat, and the ordinary oscillations are entirely avoided. As the weight remains the same the zero does not change, as may occur with instruments containing springs. The high resistance—5,000 to 6,000 ohms—of the voltmeter allows it to be employed in constant use without fear of heating. Ammeters are made of the same type and thick wire coils.

A ROUGH-AND-READY DYNAMOMETER FOR SMALL MOTORS.*

BY JOHN HOSKIN.

I have been requested to bring to your notice this evening a friction-brake dynamometer that is by no means new, but is one that is deserving of being more widely known by electricians than appears to be the case.

Like the well-known Prony brake, it acts as an absorption dynamometer, and without detracting from the acknowledged value of this instrument, especially for testing the value of large prime movers, yet we need something more portable, more convenient to use, in the very numerous cases where it is desirable to test the efficiency of small motors.

We need a rough-and-ready instrument that is portable, inexpensive, readily used, and at the same time reliable.

This we find in a friction-brake dynamometer, one of the many modifications of those illustrated by Mr. William Worby Beaumont, in his paper on friction-brake dynamometers, read before the Institution of Civil Engineers in London, November 13, 1888, and published in 1889 in the *Proceedings* of the institution.

Its construction requires only the use of a leather belt with a spring balance attached to one end, and a suitable weight at the other. The belt is to be thrown over the belt pulley of the motor, the spring balance is fastened to the floor base, or support of the motor to be tested, and the weighted end hangs pendant on the side of the pulley which, when in motion, will tend to lift the weight. When the motor is at rest, the strain of the weight should be read off on the spring balance. This reading we will call W. When the current is switched on and the motor runs at speed, the spring balance should again be read off, since the friction of the pulley on the belt will have a tendency to raise the weight; this reading we will call W′. The difference between W and W′ in pounds, multiplied by the circumference of the pulley in feet (including one-half the belt thickness on each side), and this by the number of pulley revolutions per minute will give the foot-pounds of mechanical energy, which can be compared with the electrical energy required to produce it in the usual manner.

Thus, in a few minutes, with the aid of a speed counter or tachometer, a voltmeter, and an ammeter, the efficiency of a motor can be determined, and its ability to do a desired amount of work ascertained at once, instead of being left to guesswork, as would often be the case if more bulky or elaborate apparatus were needed.

It should not be imagined from these remarks that this form of dynamometer is applicable to small motors only, but it is evident that for testing larger machines where many horse power have to be measured, the apparatus needs more elaboration, especially in the use of friction blocks under the belt or pulley strap, their lubrication, and the use of a dash-pot to steady the brake when the motive power is irregular.

But I need not enlarge on this, except to say that in these particulars, whether using steel strap, or leather belt with friction blocks, or rope friction, the same care is needed as in the Prony brake to obtain correct readings.

Before concluding, I submit to your consideration the value of the Waldron rotary pump for use as a dynamometer, although I have never heard that it has been applied to that purpose. In examining one of these engines recently for other purposes it occurred to me that it would serve as an excellent dynamometer.

This pump is operated by rotary piston blades working in a chamber, without leakage, and with but small friction, the amount of which can readily be ascertained and calculated for use as a "constant." Its capacity per revolution, and the number of revolutions being known, as also the pressure against which it works, which can be regulated by a pressure gauge, the foot-pounds of work are at once arrived at.

This method of measurement will correctly register the work done, although the speed may be irregular, and its results can be made more accurate than that of the friction dynamometer because not subject to the irregularities arising from differences in lubricants, temperature, etc., which makes it necessary to use adjusting screws in most forms of friction-brake dynamometers.

PETROLEUM OIL ENGINES.*

BY PROF. WILLIAM ROBINSON, M.E., A.M.IC.E., UNIVERSITY COLLEGE, NOTTINGHAM.

The use of ordinary petroleum oil at once as fuel and working agent in the internal combustion engine has extended rapidly since the successful introduction of the oil engine by Messrs. Priestman Brothers in 1888.

Hitherto, for large engines above 40 h.p., the heavy intermediate oils have been converted into gas by means of a gas-producer, and this oil-gas takes the place of coal-gas in the ordinary gas-engine cylinder. Now, instead of the gas-producer we find in one class of oil engine a retort, spiral coil of tubing or other vaporiser, in which the oil is heated and converted into vapour by a lamp or oil burner. A mixture of this vapour and air is drawn into the cylinder, and the charge is compressed before ignition—the cycle of operations in the engine cylinder being usually that of Beau de Rochas, as in the well-known Otto gas engine. For instance, Messrs. Crossley Bros. are making an oil engine in which a lamp performs the twofold function—first, to heat and evaporate the oil in a retort; and second, to heat the tube-igniter, which is timed by a valve similar to that in their gas engines. This lamp has a separate supply of oil given to it by a pump and a current of air from an air-pipe. The details of this and several other attempts at workable engines of this class are still in the transition stage.

Again, in the petroleum spirit engine there are many air-carburetting devices to evaporate the highly volatile hydrocarbons which make up the lighter products of petroleum, such as benzoline and gasoline. The terrible danger and risk in the storage of these light oils prohibit their common use for this purpose.

In the Priestman spray-maker and vaporiser we have a neat and practical combination of these two methods, by means of which a sprayed jet of oil is first broken up by compressed air playing on it in the inverted spray-nozzle, then it is further mixed with air, heated and completely vaporised by the hot products of combustion from exhaust led round this vaporiser or mixing chamber, before being allowed to escape. This might be called a regenerator. The oil vapour thus thoroughly mixed with air in the proper proportions is drawn through an automatic suction valve into the engine cylinder by the piston in its forward stroke. The action of this spray-maker will be seen by the following experiment: First, turn off the air supply and a flame does not light the unbroken oil jet. Next, allow the air under pressure to break up and thoroughly spray the oil, the vapour formed is so intimately mixed with air that it can easily be ignited, and burns with a bright flame. The drawings of this spray-maker also show the governing arrangement adopted in the Priestman engine. The amount of hydrocarbon is diminished or increased, together with the amount of air, so as to form a high explosive charge or a low one, according to the amount of work to be done by the engine. The air through the wing valve is rightly proportioned to mix with the oil which is allowed through the V-shaped slot cut in the conical plug regulated by the governor. By this means there is a regular explosion and impulse, every cycle giving admirable regularity of running. The compressed charge is fired by an intermittent electric spark, made to play between ends of two platinum wires insulated by porcelain in the igniting plug (shown), and connected to an induction coil excited by a storage cell of about two volts, which has been known to work for more than 1,100 hours. Each cylinder of launch engine is 7in. diameter by 7in. stroke, arranged to give an explosion or working stroke every revolution of flywheel. The actual horse-power at 250 revolutions per minute is 5·7, and 9·1 i.h.p. These engines are working in a small launch 28ft. from stem to stern by 6ft. 2in. beam, and are giving good results. Speed seven miles, and engines work with regularity. These engines are now in use on barges in canals, and also for deep-sea trawling. The horizontal type is remarkably self-contained, and well adapted for isolated electric lighting installations and lighthouse work. It is used for pumping and hauling in collieries, and for rock-drilling in mines; in fact, its sphere of usefulness is rapidly extending, because it is found reliable and steady at work, with decided economy of fuel. This is secured by thoroughly mixing the air and vapour, so as always to form an explosive mixture which gives complete complete combustion and clean exhaust. It must be pointed out, however, that during the compression of the charge before ignition a considerable proportion of the vapour comes into contact with the walls of the cylinder, condenses on them, and never gets burned, however useful it may be for lubrication. This I have proved by comparing the pressure along the compression curves of the indicator diagrams, with the pressure obtained by experiment from each charge consisting of the explosive mixture, ·015 cubic inch of oil and 191 cubic inches of air at the same temperature. Taking the temperature of the charge, 170deg. F., on entering the cylinder, the indicator diagram shows the highest pressure before ignition only 38lb. per square inch. This is kept low for fear of much condensation, as well as to give smooth running. In the gas engine we know that compression of the charge before ignition is essential to high efficiency, and similar considerations lead one to expect the same to hold true for oil engines. Indeed, by adding fresh air to the charge after leaving the vaporiser, and compressing more than usual, greater power or higher efficiency is obtained, but the temperature of the cylinder becomes too high for lubrication. In some published trials an engine may be run with a special cylinder liner to withstand the high temperatures due to high compression used, but these are not the conditions for ordinary work. In fact, for any particular oil experience must decide the degree of compression that gives best results as regards power and efficiency consistent with economy and durability of engine.

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* From the *Journal* of the Franklin Institute.

* Paper read before the British Association.

I may here briefly notice my investigation of the relation between the pressure and temperature of the vapours from different burning oil, intermediate oils, and some heavier lubricating oils, in order to throw some light on the action in the cylinder of the common oil engine. At the same time I have tried to find out which oils are best adapted for this use. My experiments prove that notwithstanding the complex and varied character of the different oils examined, the law according to which the pressure of petroleum vapour varies with its temperature is represented by a perfectly regular curve for each oil. Compare these results with the figures obtained from the different oils when used in the same engine during special tests for the purpose.

By far the simplest type of oil engine is that in which the oil is injected directly into compressed and heated air in a cartridge, which at once acts as vaporiser and combustion-chamber. Such an oil engine is the invention of Mr. H. Akroyd Stuart, of Bletchley, and is now being made by Messrs. Hornsby and Sons, Grantham. A novel feature of this engine is that the ordinary gear for firing the charge by heated tube, flame, or electric spark, is dispensed with altogether, and heavy intermediate oil is ignited and completely burned when injected into the compressed and heated air in the red-hot vaporiser or cartridge. This chamber is heated up at start with a special oil lamp supplied with air-blast by a small fan, as shown in drawings. One sees by the wall diagrams that this engine is of the simplest design. The working parts are few and simple, and some details are being improved by Messrs. Hornsby and Sons. The oil-cistern is fitted in the base of the casting, exposed to ordinary atmospheric pressure, and the oil supply can easily be replenished at any time during a run by sliding open a top cover and pouring in the oil.

Every charge of oil is forced, by means of a positive action oil pump, through a thin pipe and simple nozzle into the vaporiser at the proper moment for ignition, just after the hot air has been compressed and the piston is on the return stroke. The oil supply is regulated by a governor, whilst by using a large flywheel and high speed, about 210 reospermins, this engine runs very steadily. I tried a 6-h.p. engine during a run of about three hours, using oil of specific gravity ·854, and flashing point 220deg. F., and the consumption was less than a pint per brake horse-power per hour. Even heavier oils might be tried, the hot water from the water-jacket going to warm up the heavy oil and keep it in a fluid state fit for use in winter.

The action in the engine cylinder is here very different from that in the Priestman, inasmuch as there is an excess of air in the cylinder, and this is compressed before the oil is injected. Consequently, the combustion is rapid and will be complete even when heavy oils of great heating power are used. However, since the air is dry, and there is no condensation of oil, the cylinder requires independent lubrication, as in the case of the gas engine.

A feeling of safety to the public naturally tends to the use of heavy oil, from which the lighter constituents have been distilled. I have found the loss in weight of some heavy oils by prolonged heating at low temperatures, keeping the oils exposed to the air and allowing free evaporation. Known weights of oil were taken in shallow dishes, about 3in. across top, and gently heated on a sand bath by a very small steady flame for three hours, the temperature of the oil being kept constant. The proportion of volatile constituents present in the samples are indicated.

EVAPORATION.

Name of sample.	Specific gravity at 60° F. (15° 5C.)	Constant temperature (Centigrade).	Time of evaporation (hours).	Percentage loss.	Total percentage loss in 3 h'rs.
Broxburne lighthouse oil used in Priestman engine	·811	40 to 45	1·5	1·63	6·90
		60 to 65	1·5	5·27	
Intermediate shale oil.........	·849	40 to 45	1·5	1·12	3·57
		65 to 75	1·5	2·45	
Lubricating oil used in Hornsby-Akryod engine	·854	40 to 45	1·5	1·00	2·96
		60 to 65	1·5	1·96	
		Steam bath (95)	3	12·42	12·42

The terribly explosive character of the hydrocarbons driven off at the ordinary temperature renders the safe storage of petroleum imperative. Instead of the present tank system, Mr. B. H. Thwaite has devised the safety oil-tank which the wall diagram and model explain. It is very much like a gas-tank, the cover-plate being kept in contact with the oil and counterbalanced by weights to give only a slight pressure of 1in. or 2in. of water on the surface of the oil. The frame moves into an annular water seal standpipe, to draw off any gas that collects. There is no necessity for the introduction of air to allow the tank to be emptied, and as the oil is kept cool, and always under pressure, it is impossible for a dangerous explosive mixture to accumulate inside the tank.

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THE ELECTRIC LIGHT IN BUSES.

Mr. W. Langdon before the Institution of Civil Engineers, and Mr. Timmis before the British Association, have discussed the applicability of electricity to train-lighting. Of these two papers that of Mr. Langdon is of greater importance, inasmuch as he is officially connected with one of the most prominent railway systems in the kingdom and therefore his conclusions may be taken to represent those of the Midland Railway. Mr Langdon admits that lamps as originally provided, "were intended simply to enable passengers to enter and leave the carriage without inconvenience. The exigencies of the present time however, call for the additional luxury of a light for reading purposes . . . and it must be admitted that in lighting and warming there yet remains something to be accomplished." These admissions are to be found at the beginning of the paper, while at the end we have these pregnant sentences: "Regarding electricity as the illuminant which will at no distant date be universally employed for train-lighting, the author would avail himself of the opportunity to impress upon all who may determine upon its introduction the propriety of arriving at a common basis in regard to the following fundamental principles:

"1. The electrical system to be pursued.

"2. The form and position of the electrical coupling.

"3. The pressure of the current."

The reason for urging attention to these points seems to be the wish to avoid diverse systems, especially as carriages do occasionally run over foreign lines, and it leads to endless troubles if the systems adopted for various purposes widely differ. Thus train-lighting seems to be following the natural order of things—has been experimentally tried and found better than other illumination, and will gradually be extended. Its development is in good hands, and while the work will be watched with considerable interest, there is no reason to believe there will be any retrogression. But while train-lighting is of greater importance, there can be no doubt that improvement is urgently needed in the lighting of buses and tramcars. The oil lamps as hitherto used, smell atrociously, and serve only to make darkness visible. Here, however, progress is reported. It is stated that the electric light, having been experimentally tried in lighting some 60 omnibuses for the space of a year, the results have been deemed so satisfactory that a large extension is to take place immediately. In the question of buses there can be no two opinions as to system. There is only one system applicable, and that is by means of batteries, either secondary or primary. In our opinion the latter are not in the running, but inventors and promoters deem otherwise. What is wanted is a light battery which will stand the awful jolting of the streets, and yet not to appreciably increase the weight the horses have to pull, the maintenance at the same time to be reasonable. The lamps, again, must necessarily be of the incandescent type, and should be so hung as not to suffer from the jolting. We do not know the exact results of the experiments, but as it is said the light will shortly be working in most of the London omnibuses, we take it for granted that some satisfactory solution has been found, and that the initial outlay and cost of maintenance is such as to interpose no obstacle in the way of extended use. If we ever reach that happy time when the greater part or the whole of the omnibuses, tramcars, carriages, and vehicles of all kinds are driven by electricity the lighting will present little trouble. The time must come when horses will very largely give place to electricity, but not till electrical mains are as common as water-pipes—when Lord Tomnoddy will order his carriage to be driven by means of electricity, stable his carriage in the coachhouse of his friend whom he visits, if necessary take on board some more electrical energy by means of wires on to the terminals of the carriage battery from the house terminals, which will by-and-by be found in every house, and the visitor, instead of having a "feed" given to his horses, will have a "feed" given to his batteries. Is that too much to foretell? How soon will the visits of the veterinary surgeon cease and the electrical engineer commence?

THE BRUSH COMPANY.

We are told that the country is happy that hath no history, but the same hardly holds true of a company. A successful company, judged by the interest taken in the general meetings, has little or no history for the public, but it nevertheless has an history which, if told, would be seen to be important. It is the company struggling to success, it is the company struggling adversely, whose histories are in every mouth, and whose condemnation is unanimous. Once let a company turn the corner and it finds friends everywhere, but experience up to that point is that the world's help is in kicks and not in halfpence. Unless we are mistaken, the electrical companies are no exception to this rule. Another statement too often in the mouths of people, is wholly incorrect when applied to company working. It is that in the multitude of counsellors there is wisdom. So far as company work is concerned, a multitude of counsellors means the bankruptcy court, and being given over to the spoiler. Every successful company owes its success to the domination of the counsels of one or two energetic men. They initiate plans, their colleagues agree to carry them out, and the staff working together bring the plans to a success. If there is no dominating individual in the company, there will be no great success. We do not know whose will has been predominant in the Brush Company's working—it matters not, but we are certain someone has had ascendancy, or the company would long since have collapsed. As it is, the near future promises to put it upon a thoroughly sound footing. Long since we recommended the purchase of Brush shares for permanent investment. It was no random recommendation, and time has proved the correctness of our conclusions. The company has been going from better to better, and unless there is division in the camp itself must continue to progress. The balance-sheet given in our last issue, and the report of the meeting given in another part of this issue, will, even when taken *cum grano salis*, justify the conclusion that the policy of the company is one that leads to success. The work carried out by the company shows that both in the electrical and engineering departments the responsible heads are fully alive to the necessity of all work being above reproach, and an investigation of installations carried out bears indication of every detail having received careful consideration. Concurrently, then, with financial ability, the company possesses electrical and engineering ability of the first order, and if such a combination does not mean success it is difficult to say what does. The work of the company most prominent in the eyes of the public at present is that in connection with the lighting of the City of London. As is well known to our readers, the City was originally divided into three districts, and the work divided between two firms. An amalgamation has since taken place, and the work is now being carried out under the control of one company. This company has entered into extensive contracts with the Brush Company to supply central station apparatus, and these contracts are being rapidly executed. The public lighting of London City is the smallest part of the work that will result from a successful carrying out of the enterprise; for we may rest assured that the private lighting will rapidly follow the way of the public lighting, so that streets and warehouses will be by night "as bright and busy as the day."

FESTINIOG.

A further instance of the how-not-to-do-it method as regards public electric lighting contracts seems to be furnished in the invitation of the Festiniog Local Board for plans and estimates for the supply of electricity to the village of Festiniog and the district of Tan-y-Gresian. The Board state that there is ample water power available, and that they will not defray the cost of preparing plans or estimates, nor will any estimate, if necessary, be entertained. Plans and estimates to be sent before the end of October to Mr. R. Walker Davies, solicitor, Blaenau Festiniog, North Wales, who will supply any further information. Now the "village" of Festiniog may have plenty of water power for nothing, but those who remember its attractions can hardly suggest a very large number of lights as possible. To ask contractors to send in plans and estimates, means in all probability that an engineer must be sent down and a set of draughtsmen must be employed for so many hours by each contractor tendering. If 20 contractors spend £20 each—

not, perhaps, an excessive amount—we have £400 gone, probably a large fraction of the amount needed to erect the whole installation. Nineteen of those tendering would lose the contract, and one would gain it; the cost of the nineteen will have to be borne by someone—not the Local Board of Festiniog. If the Local Board wish to obtain a benefit from their water power they ought to be, and we hope they are, prepared to spend sufficient at least to save contractors the expense of preparing for them definite proposals, besides that of giving all required information as to prices in public tender.

LITERATURE.

The Arithmetic of Electrical Measurements, with Numerous Examples Fully Worked. By W. R. P. Hobbs. New Edition. Murby, 3, Ludgate-circus-buildings, E.C.

This book, as the title indicates, is merely a collection of questions requiring numerical answers involving the simpler formulæ connected with electrical work. We quite agree with the author that mere reading will never make an electrician, just as the mere reading of a book on building would not much assist the navvy in tying a putlog to a scaffold pole. Many people who fancy their knowledge of a subject to be exact and extensive would have a bad quarter of an hour answering the questions of an audience after giving a popular lecture on the subject. Two of the best ways of learning the kind of knowledge you possess will be to undertake to deliver a popular lecture upon an engineering subject before a body of working engineers, or to give written answers to a series of simple questions. Difficult problems will take care of themselves. Men of leisure and brains will always be found willing and ready to undertake the investigation of the unknowable and erect hypotheses thereon. What we want is books of this simple character and an extensive use of them.

Telegraphy. By W. H. Preece, F.R.S., and J. Sivewright, M.A., C.M.G. Ninth Edition. Revised and Enlarged. Longmans, Paternoster-row.

A book that has gone through nine editions needs little to be said as to its merits or demerits. Proof has been emphatically given that the former are prominent and the latter hidden. Such might not be the case perhaps if there were no other books on telegraphy, but, as is well known, their name is legion; hence the greater the pronounced success of this book. Yet there ought to be no difficulty in understanding this success. The authors have been in the forefront of telegraphic work during the whole of their working lives, have had exceptional facilities for becoming acquainted with every new detail in the progress of the last quarter of a century, and, what is of far greater importance, are in the position of knowing exactly what improvements have proved successful in practice, and what designs have failed when put to the test. Some years ago now, and in a publication not directly connected with the electrical industry, we remember mildly suggesting inability—an inability still holding—to quite agree with the way in which the term "quantity" is used in the second paragraph of this book. Other than this, we have nothing but praise for the matter and method of the book.

CARBON SWITCH.

The Allgemeine Company, of Berlin, have recently introduced a carbon switch, Fig. 1, for the gradual breaking of the field-magnet circuits of large dynamo machines. With ordinary quick-break switches the breakage of a large current, owing to the self-induction, often generates a very high momentary pressure, which may easily pierce the insulation and do much costly damage to the field-magnet coils. This disadvantage is obviated in the carbon switch, in which, at the breaking of current, two paths in parallel, Fig. 2, are open to the current. One of these being from carbon to carbon, an arc is set up, which by the gradual separation of the carbons becomes of higher and higher resistance, until when the current breaks there is hardly any production of extra current. After the breaking of the current at the metal contacts, the carbons come automatically together again next time the circuit is made.

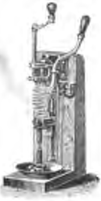


FIG. 1.

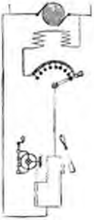
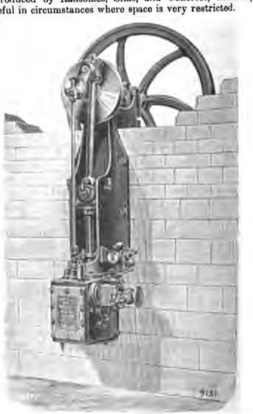


FIG. 2.

IMPROVED WALL ENGINES.

The illustration herewith represents a wall engine lately introduced by Ransomes, Sims, and Jefferies, extremely useful in circumstances where space is very restricted.



These engines are specially adapted for driving overhead shafting, to which the engine crankshaft may be coupled direct, the engine being placed on the outer side of the end wall of the building, and protected by a small shed with lean-to roof. By this arrangement the engine is readily accessible, and, while it is protected from the weather, the working parts are preserved from injury by the dust and dirt of the workshop, an important consideration in connection with certain industries.

The engine being fixed to the end wall of the building, the crankshaft occupies a position at right angles to the face of the wall, and any stress due to the vibration of the engine is transmitted to the wall in a direction parallel with its length—*i.e.*, in the direction in which the wall is best suited to withstand such stress. These engines, therefore, obtain a distinct advantage over the usual form of wall engine, which is bolted to one of the side walls of the building, in which latter type the crankshaft being parallel with the face of the wall, the stress is transmitted to the wall in the direction at right angles to its length. Where the speed of the shop shafting does not correspond to the speed of the engine, the latter may conveniently be arranged to drive the shafting by belt.

The engine frame, with the guide-bars, is in a piece with one of the plummer blocks, and is bolted to a casting which forms the outer plummer block, and which in some cases is brought up so as to form a box above the crankshaft, thus supporting the wall over the engine. The centre casting, at its further extremity, is rigidly secured to a large wall-plate arranged on the opposite side of the wall to the engine cylinder; the bolts securing the engine to the wall passing through this plate, any possibility of either plummer block springing is thus avoided.

These engines are sometimes made with a double crank, so that the power can be taken off from both ends of the crankshaft. Each engine is fitted with a sensitive governor acting direct upon an equilibrium piston valve, and efficient means of lubrication are provided.

SUNBEAM LAMPS.

Mr. J. W. Swan once publicly expressed his opinion, if we rightly remember, that the arc lamp had but a very limited application, and that eventually incandescent lamps would carry nearly everything before them, both for public and private lighting. Now, although there is much to be said pointing to the great extension of arc lighting throughout the world, it certainly seems, more particularly in this country, that the arc light is very far indeed behind the incandescent lamp as a lighting agent. Everywhere we are beginning to see incandescent lamps burning—in houses, shops, and factories—and but seldom the arcs. Incandescent lamps are made by the million, arcs by the dozen or the hundred.

The reason of this is not far to seek. In spite of the lesser current for the greater light that the arc lamp gives, daily attention is required, daily consumption of carbons is experienced, while the incandescent globe burns right through, with but occasional need for attention beyond the turning of the switch. It is for this same reason that the high power incandescent lamps—better known under the name of "Sunbeam" lamps—have found so much favour for large candle-powers. With them, also, no daily attention or renewal is required, and, in addition, we have a perfectly steady and withal a warm light, which, especially for large halls, seems to be infinitely preferred to the intense glare and dazzling intensity of the arc lamp. There is no hissing or blinking, and they require no attention from the time of their first instalment till they give way—a matter of months, many or less, according to use. With reference to ordinary inside lighting these lamps also have their considerable use; for when dealing with large shops, halls, or stations and so forth, it is often very greatly preferable to use one large incandescent lamp than many small ones, both as regards the first cost of wiring and lamps, and also the cost of renewals.

These high-power Sunbeam lamps are made usually in two classes: one of long-duration carbons, for places where current is cheap and lamps are a consideration—for a factory producing its own electricity, for instance; and the other of high-efficiency carbons, for situations where current is the chief consideration. We give below the latest table of comparative currents, voltages, and candle-powers:

Current Required for Sunbeam Lamps.

Class A.—High Efficiency Lamps.

Candle-power.	Amperes at 50 volts.	Amperes at 65 volts.	Amperes at 80 volts.	Amperes at 100 volts.
150	6	5	4	3
200	8	6	5	4
300	12·5	9·5	8	6
400	16	12·5	10	8
500	—	16	12·5	10
600	—	—	16	12
800	—	—	20	16
1,000	—	—	25	20
1,200	—	—	31	25
1,500	—	—	—	31
2,000	—	—	—	42
Class B.—Longer Duration Lamps.				
150	7·5	5·5	4·7	4
200	10	7·5	6·5	5
300	15	11·5	9·5	7·5
400	—	15	12·5	10
500	—	—	15	12·5
600	—	—	—	15
800	—	—	—	20
1,000	—	—	—	25
1,200	—	—	—	—
1,500	—	—	—	—

These lamps are made for running in series for a current of 5, 6, 8, or 10 amperes, on their own or on an arc lamp circuit; these series lamps are made of various candle-powers.

As the efficiency of these high-power lamps is very high, special care should be taken when using them that the voltage of the current never exceeds that for which the lamps are required. Want of care in this respect, or the use of a pulsating or irregular current, is found to be the most frequent cause of failure of incandescent lamps.

FRANKFORT EXHIBITION.

Messrs. Felten and Guilleaume, the well-known firm at Mülheim-on-Rhine, exhibit largely in the so-called Distribution Hall, where all conducting material and systems of distribution are shown. A part of their show is seen at once on entering through the northern entrance, and the remainder is immediately adjacent on the left. The former contains more particularly the cables and insulated wires, as well as two fully-mounted nets of cables for electric lighting—*i.e.*, one each on the three-wire system and for alternate current. In the side room a Ferranti cable is shown in the different stages of manufacture, with joints; also uninsulated wires of different materials and for various purposes, and wire ropes are exhibited.

The principal exhibit of Messrs. Felten and Guilleaume's is, in common with Schuckert's, surrounded by six high candelabra with Schuckert's arc lamps, and four smaller ones with Schuckert's glow lamps. Short pieces of wire rope made of fine wire form in combination with the candelabra and some columns a balustrade, which closes the show against the passengers. The two large pictures suspended between the small candelabra show the two works of Messrs. Felten and Guilleaume—namely, the Wire, Wire Rope, and Cable Works, Carlswerk, at Mülheim-on-Rhine, and the Hemp Spinning Mill and Mechanical Twine Factory, Rosenthal, at Cologne. Above the passage to Schuckert's show a 27-core aerial telephone cable is suspended to a wire strand fixed to the candelabra. Aerial wires are stretched higher up on the two sides, these aerial wires being connected to the telephone cable by means of joint-boxes and intermediate rubber cable.

In the corners next to the entrance there are on the left a column built of galvanised wire and wire strand, on the right a similar column formed of copper and brass wire, lead coated copper wire for accumulators, and copper strand. The two columns on the right and left of the passage to Schuckert's show represent the different kinds of cables, as lead-covered cables, cables sheathed with wire, and iron tape rubber cables, house leads, etc.

The attention of the visitor on entering from the north is drawn to a large street cable-box, mounted on brick foundations, and surrounded by masonry, finished off with a cast-iron manhole frame and cover.

This box is arranged on the three-wire principle, and shows how the feeding and distributing cables are introduced into it. The box is provided with a hermetically closing cast-iron cover, and is divided into a central part for the distributing arrangement, and a circular outer part for the connections. Again, this circular part is divided into eight chambers (more or less according to requirements), each for the reception of three cables, or 24 in all, being three feeders and 21 distributing cables. The chambers are, especially where the box is exposed to the danger of inundations, filled with insulating material poured in hot, which solidifies when cooling, in order to protect the cable ends as much as possible against moisture. The distributing arrangement contained in the central part of the box consists of three metal rings insulated from each other, to each of which one of the feeders is connected by a gunmetal bridge, whereas the distributing cables are connected by lead fuses.

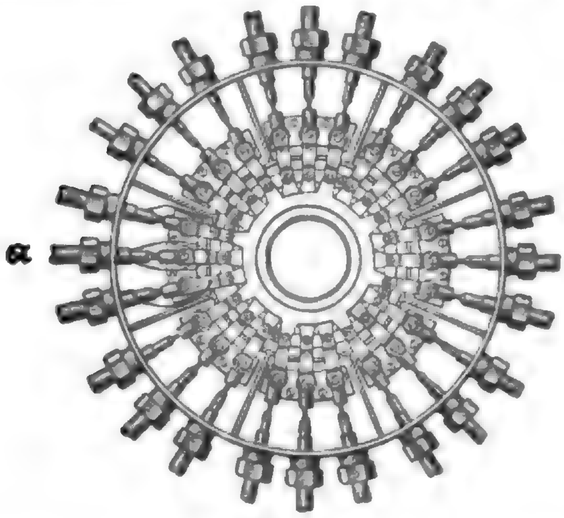


Fig. 1.

Similar boxes are manufactured by Felten and Guilleaume for the two-wire system, as shown by Fig. 2. The arrangement of the pit, in which the box is mounted on brick foundations, is shown in Fig. 3. Any water penetrating in the pit is made to escape underneath the box.

On the left (east side), a small net of cables arranged on the three-wire system by single conductor cables is shown, and on the right (west side) a similar net arranged for alternate current with concentric cables, the joints and branch-offs being protected by cast-iron boxes. For the better showing of system of joints and branch-offs, some open joint-boxes with loose covers are exhibited, some of which, being those most usual for electric lighting, are represented in Figs. 4, 5, 6, 7, 8, and 9.

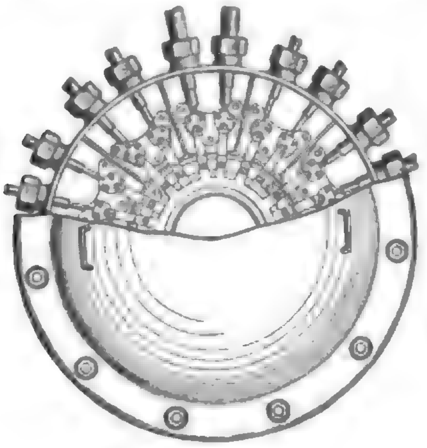


Fig. 2.

A great display of samples of cables and other conducting material for all imaginable purposes is arranged in the kiosk. This collection is not only worthy of consideration on account of the whole arrangement, but much more interesting in detail. It is difficult to explain the construction of a cable in any better manner than by showing its section, and that this section is finely polished is not done for forming a nice outside only, but principally for the merely practical consideration that in a polished surface the form and dimensions of the wires and other elements forming a cable are more easily distinguished than in a roughly-cut section. The firm has not confined its task to exhibiting cable sections only, but also exhibits samples for purposes of instruction, showing internal details, raw materials, and half-finished articles in different stages of preparation, offering the greatest interest and objects of study to the initiated. The following details of the samples exhibited may be of general interest.

Lead-covered Electric Light Cables.—Lead-covered cables for electric lighting and transmission of power are manufactured by the firm from the smallest sections up to 1,000 square millimetres, be it for continuous, alternate, or rotary current. The cables are preferably covered with a double lead cover, put on by hydraulic pressure, although on special desire they may be supplied with a single lead cover. The thickness of lead may be fixed according to requirements. The firm supply the cables in any length, the only limitation being the possibility of transport. The insulating material generally consists of impregnated fibre or impregnated paper or both, or of indiarubber for very high tensions. The cables are concentric for alternate current, and biconcentric for rotary current. Outside of the lead cover the cables are, according to local requirements, provided with another cover of round or flat iron wires, or iron tape, finished off with a layer of asphalted jute yarn or tape.

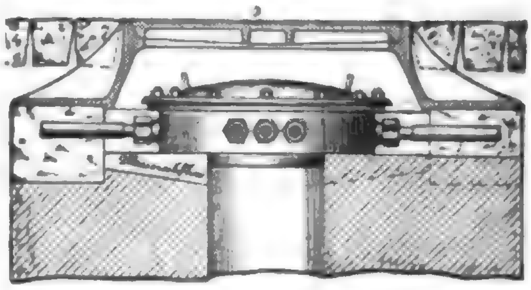


Fig. 3.

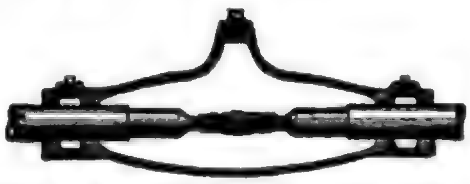


Fig. 4.—Joint-box for Single Cables. The copper cores are connected by interlacing the wires and soldering.

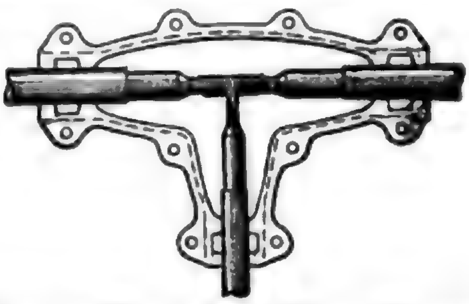


Fig. 5.—Branch-off Box for Single Cables. The copper cores are connected by winding the wires of the branch cable round the main copper core, and soldering.

A piece of lead tube having 68 millimetres inside and 78 millimetres outside diameter, demonstrates the excellent work done by Felten and Guilleaume's cable presses. Another piece of lead tube is shown, having 25 millimetres inside and 35 millimetres outside diameter, sheathed with 24 iron wires of 2·8 millimetres diameter, each covered with tarred hemp to a thickness of five millimetres. This tube is part of one several hundred metres long, supplied by the firm to a salt works for use as a brine conduit.

Cable Joints.—This collection includes joints in different stages of progress as made in indiarubber and guttapercha cores, and joints in lead-covered electric light cables without the use of joint-boxes, as carried out by the firm with great success in several large lighting installations. Especially worth mentioning are the branch-offs executed in the same way, and which are wrapped with iron tape in cases where such protection is required.

Telegraph Cables with Differently Insulated Cores.—Although offering nothing new to be seen, the usual iron wire sheathed telegraph cables with guttapercha and indiarubber cores, as supplied by the firm for a long time past both in and outside of Germany, could not be omitted from the collection. However, among them is to be seen an underground telegraph cable covered with flat iron wires for being drawn into conduits, where their lighter weight and smoother surface form an advantage. This cable is a new type.

For use in the tropics, indiarubber cables, which are better able to resist heat than guttapercha cables, are generally preferred to the latter; guttapercha at high degrees of heat softening and allowing the copper to get through the insulating covers. Felten and Guilleaume's impregnated fibre and paper cables behave in the same or even better manner than indiarubber cables, and are much cheaper than these.

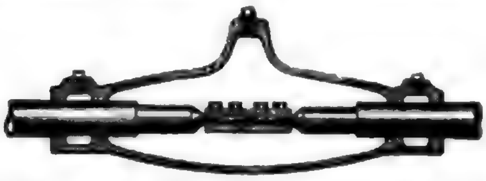


FIG. 6.—Joint-box for Single Cables. The copper cores are connected by means of clamps.

Of course, it is essential that impregnated cables be lead covered to render them impermeable against moisture, and according to local requirements an asphalted covering of yarn or tape, or even a sheathing of iron wire or iron tape, is necessary as a protection against mechanical injury. Even for guttapercha and rubber cables it may under special circumstances be necessary to insert a lead tube between the core and the sheathing, especially where, as in tunnels, the cables are exposed to chemically impure waters, or where they are laid in stagnant waters, and generally everywhere they are exposed to acids mixed with water, steam, or smoke, or to fouling substances. This precaution has, for instance, been used in the St. Gotthard Tunnel.

Electric Light Cables with various kinds of Insulation.—The various conditions under which light cables are employed, with regard to conductivity, insulation, capacity, low or high tension, mechanical strength, flexibility, and size, are of course to be taken into consideration in the choice of the insulating material and of the composition generally.

The samples exhibited represent cables with guttapercha and indiarubber insulation, as used in river crossings or in damp localities; further, cables with impregnated fibre and impregnated paper insulation, especially those for very high tensions; cables with copper cores consisting of proportionately thick wires, and those which, where, as in theatres, great flexibility is required, are composed of very fine wires.

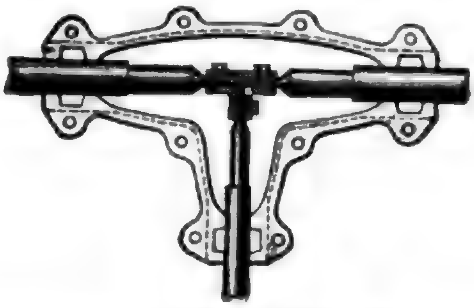


FIG. 7.—Branch-off Box for Single Cables. The copper cores are connected by means of clamps.

Telephone Cables.—With regard to mode of insulation the telephone cables do not show any marked difference from telegraph cables, except that in the former smaller copper wires are used, which are also insulated to a smaller diameter. Telephone cables are further characterised by the larger number of conductors in one cable and the special regards taken as to capacity and induction. Details have already been given how Felten and Guilleaume arrange these details in the construction of their telephone cables, for which the numerous samples exhibited bear eloquent testimony.

Torpedo Cables.—These cables have to answer many requirements which are often difficult to be complied with all at the same time. The choice of material and construction of torpedo cables are therefore very important. They must combine the smallest possible volume and weight with sufficient conductivity, insulation, and strength, and possess great flexibility. The insulating material must resist high degrees of heat without deterioration. In order to comply with all this, it is usual to compose the conductor of a great number of very small wires, partially of copper, partially of steel or bronze of high breaking strain. The insulating material is usually indiarubber; the exterior covering is made of yarn and braiding. Sometimes sheathing wires are applied, but then they are put on in the forms of strands or cords composed of very small steel wires.

Messrs. Felten and Guilleaume have for many years past supplied cables for military purposes to the Imperial German and other Governments. The great variation of the specimens shows how different the requirements to be complied with are.

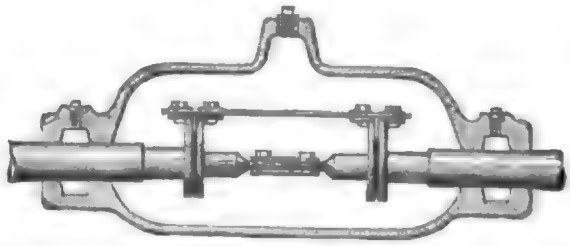


FIG. 8.—Joint-box for Concentric Cables. The inner conductors are connected by clamps, the outer conductors by clamps and rail.

The table placed near the entrance to Schuckert's show carries specimens of several raw materials—as guttapercha and indiarubber—in the different stages of preparation, as well as in the finished state ready to be used for insulating purposes. Six tableaux, arranged in the centre of this table, show the great variety of leads for house connections made by the firm—such as bare, cotton-covered, taped and braided guttapercha and rubber cores, waxed wires, arc and glow lamp connections, silk-covered wires, dynamo wires, suspension cords for arc lamps. This show is crowned by a specimen of light cable laid in the River Pregel.

On the left the first objects noticed on approaching are the Ferranti cables, exhibited by the firm, such as are used for the Deptford lighting installation at London. Every piece of sample bears a ticket with the explanation in German, English, and French. There are:

1. The inner conductor not insulated.
2. The inner conductor insulated.
3. The inner conductor insulated, with the outer conductor drawn over it.
4. The inner and outer conductors, both insulated.

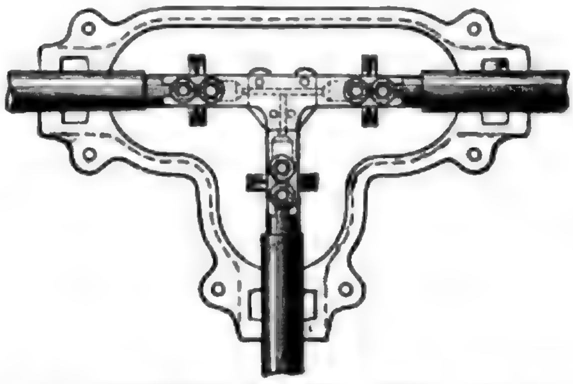


FIG. 9.—Branch-off Box for Concentric Cables. The inner conductors are connected by clamps, the outer conductors by clamps and rail.

5. The finished cable, with its protecting casing of iron.
6. A joint taken to pieces to show the conical preparation of the ends.
7. Another joint, also taken to pieces, partly finished, showing the manner of connecting the ends of the outer conductor by putting a copper sleeve over, which is fixed to them by corrugations.

Each of the two conductors has a copper section of 160 square millimetres, sufficient for a current of 250 amperes. The size of dielectric is calculated to suit a tension of 10,000 volts.

Three columns are built up near the Ferranti cables. One of them contains coils of bright annealed, varnished and galvanised iron and steel wire in the qualities mostly used for various purposes. Another column is composed of copper and bronze wires, and the third of wire ropes, including those for lamp suspension and lightning conductors. It is impossible to demonstrate at a show the inherent qualities of wires and wire ropes. Only such outward signs of good qualities as smooth surface, equality of size, regularity of section, good galvanising, and for wire ropes the different constructions can be demonstrated to the eye; whereas breaking strain, flexibility, ductility, and electric conductivity are warranted to be correctly indicated by the respectability and repute of the firm of Felten and Guilleaume.

Iron tape as used in the sheathing of lead-covered cables is exhibited in several rolls of various widths, also galvanised. The copper smelting, hammer, and rolling works are represented here by cast and hammered blocks of copper, and bars of copper and brass. A board suspended to the wall bears original coils of fine bronze wire. A smaller board exhibits specimens of copper bands for projectiles, and a piece of rolled compound wire showing the disposition of the steel core and copper mantle. A length of patent locked coil wire rope is deposited in one corner of the room: smaller pieces of such ropes, to be seen near it, distinctly show the arrangement of the differently shaped wires in them.

ELECTRIC MOTIVE POWER FOR STREET SURFACE RAILWAYS.*

Last May I received a letter from the president of this association asking me to prepare a report to be read at this meeting "on any subject covered by the range of electric motive power for street surface railways." In that letter the president, seeking to lure me to my destruction, stated that many months would yet elapse before the next meeting of the association, and closed by expressing the hope that I would oblige him personally by complying with this request. I have been in so many situations where I have found it necessary to call upon my friends to oblige me, that I could not find it in my heart to deny the president this request, especially as my promise, if made, was to do something months hence. I attached a string to my promise in the concluding part of my letter of acceptance, in which I stated that I did not see how I should get time to prepare anything worth the hearing, but that I would do my best.

I expected, when I agreed to write something for your consideration, that I would have an opportunity before preparing what I had to say of talking with the president of this association, and of obtaining from him some suggestions upon which I might hang the slender thread of my thought. That pleasure, by reason of his and my business cares and engagements, has been denied me, and only the other day I was brought up with a round turn by a letter from the secretary reminding me that I had agreed to prepare a paper for this meeting upon the subject of "Electric Motive Power for Street Surface Railways." The reminder that the time had come for the fulfilment of my promise was almost as disagreeable to me as an electric shock administered by a 500-volt current, but the unpleasant features of that situation were considerably modified by the statement that the secretary, or someone acting through him, had been kind enough to formulate and put into quotation marks for me a definite subject for my paper. The fact that the subject is deeper than any well and wider than any church door is, to be sure, a little embarrassing. I am encouraged, however, to say what little I can upon this very comprehensive subject by the knowledge that, while I know really very little about it, yet there may be some others engaged in the street railway business who have had less experience in the operation of street surface railroads by means of this unseen and wonderful force called electricity.

The subject which has been given to me is many sided. I shall endeavour to throw out a few suggestions, based upon some study of the problem of street railroad transportation, and upon a little experience. If in what I shall say I am able to furnish one or two texts for discussion, I am sure there are those present who, by their discussion of the texts, will furnish all of us with valuable information and food for thought, and thereby my purpose will have been attained.

Most of us are engaged throughout all of the working hours of each day in the performance of duties which leave us little time for reflection upon and study of the broad questions suggested by the subject which has been given to me. We all know that the tendency of modern American life is toward the concentration of vast masses of people in our towns and cities, and that this urban increase is somewhat at the expense of the agricultural communities. We also know that the American workman, as well as the American business and professional man, is seeking to locate his home some distance away from the section of his town or city where his business is transacted, or where his work is done. Every householder has, or desires to have, at least a little patch of lawn or garden about his home, to obtain which, he must locate some distance from the business or manufacturing centre of the town or city where he lives. To the average man, however, this is not possible, except as he can have some means of communication with that business or manufacturing centre, at low cost to him. But as towns and cities grow, and distance becomes more and more an element to be considered, it becomes necessary that the citizen should have not only facilities for cheap transportation for himself and the members of his family, but that he should have means of rapid intercommunication. Out of the needs of modern city and town life grew the horse railroad. The development of cities and towns brought with it the necessity for quicker transportation. The American intellect, ready to meet every emergency, set itself at work to devise some method of quickly transporting the people of the great cities of the country, and so far as the great cities are concerned, practically solved the problem presented by inventing and building cable railways. It was soon found, however, that while cable railways answered the purpose for which they were designed in cities like Chicago and Philadelphia and New York, they would not do in smaller cities, except in isolated cases where vast numbers of people were required to be moved daily over a comparatively short mileage.

Five years ago the only street surface railways which were in successful operation anywhere in the United States were horse and cable railways. Within that five years more than 4,000 street cars have been electrically equipped, and to-day more than 3,000 miles of track in 300 cities and towns of this country have been constructed, on which these electric cars are run with satisfaction to the people, and, in the main, with profit to the companies operating them.

The development of the street railway has had as much to do with the growth and prosperity of the towns and cities of this country as, or perhaps more, than any other one thing. The transportation of people by street railroads is most intimately connected with the social and business life of the people. Nearly 500 cities in the United States have street railway systems in operation. More than 800 corporations are operating street railways in such towns and cities. As many as 30,000 street cars—horse, cable, and electric—are to-day running upon the 8,000 miles of street railroads in this country. In these cars, and on these tracks, are carried as many as 3,000,000,000 of people yearly, or 50 times the entire population of the United States. When we consider that the number of people carried by all of the steam railroad companies in all of the States of this Union last year is estimated at less than 500,000,000, and that more people are carried on the street surface railroads in the city of New York in a year than are carried by all the steam railroads of the State in the same period, we come to have some conception of the immense importance to the people of the rapid, efficient, and safe service of street cars in the rapidly-growing cities and towns of this wonderfully prosperous country. Think for a moment of the daily loss to the people of any city where horse cars are run at from four to six miles an hour, as compared with the operation in the same city of electric or cable cars, running from six to twelve miles an hour. Consider the immense increase in the value of property in our municipality, caused by the introduction of rapid transit. Consider the wholesome influence upon the people of every community where the husband, or other head of a household, is able, by means of facilities of quick transportation, to take his midday meal with the members of his family. The best thought of this time may well be expended upon this great question of furnishing quick, safe, cheap, and comfortable transportation to the people whose lot it is to dwell, as dwell they do in such vast numbers, in the towns and cities of this land.

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* Report of the Committee on Electric Motive Power for Street Railways to the Street Railway Convention at Pittsburg.

The problem which is presented to the street railroad man of to-day must be considered, not simply with reference to the populations as they now exist, but with reference to the great increase of population which is certain to come. There are 74 cities in the United States which have a population in excess of 40,000. The total population of these 74 cities, as shown by the last census, is nearly 13,000,000, and the average increase of population in these cities during the last decade is nearly 47 per cent. In this State there are 28 cities having a population in excess of 10,000, and a total aggregate population of nearly 3,500,000. The average increase in population of these cities, in the past 10 years, has been more than 33 per cent. For all these growing towns and cities in our own State, and throughout the country, what can electricity do as a motive power for the operation of their street railroads ?

We, who have had to do somewhat with the change of the system of operation of street surface railroads from horse to electric power, know that we have now passed beyond the experimental stage, and are beginning to tread upon ground which seems firm under foot. We hear now and then fears expressed by doubting Thomases as to whether the motors are going to last, as to whether the repair bill is not going to wipe out all profit, and as to whether the great expenditure which has been and is being made on our railroads may not be thrown away because some new and wonderful principle is to be discovered which will enable our railroad companies to operate their roads with commercial success by means of storage batteries. We find in some communities so great a prejudice against overhead wires that railroad companies are unable to obtain the necessary franchises and privileges, the granting of which would result in giving those communities the benefits of rapid transit with electricity as motive power. Hour by hour, however, experience is teaching all doubters that the problem of rapid transit for cities has been solved, and that the trolley has come, and come to stay.

As this convention is held in the city of New York, where as yet the people have not had a practical demonstration of the merits of the trolley system, it may not be inappropriate to look at this question from the point of view of the New York citizen, and to meet, if we may, some objections which are here urged to the trolley system, so called. I have read with some interest much that has appeared in the great New York dailies with reference to the horrible condition of things which exists in towns and cities where the trolley system is used for street car propulsion. Our friends over in Brooklyn have been endeavouring since the last meeting of this association to educate their townsmen upon this matter, and with at least a reasonable measure of success. To them, and indeed to all of us, the facts which are perfectly well known have become trite from iteration. Everybody knows that a rapidly-moving car, whether the propelling force is furnished by horses, by steam power exerted upon a steel rope, or by electricity, will hurt and perhaps kill the person with whom it comes in contact, but the rapidly-moving car is essential to rapid transit. An electric car can be stopped as quickly, indeed more quickly, than can a cable or horse car running at the same rate of speed. Collisions occur with one system of transportation as much as with another, but we contend, so far as the danger question is concerned, that the only danger to life or limb from the operation of electric cars comes from the possibility of collision with persons or vehicles, and that there is no danger from the electric current itself propelling the car. As I have stated, electric cars have been operated during the past year on more than 2,500 miles of track, and, although millions of people have been carried upon these cars, no instance can be given of serious injury to any person by reason of shock caused by the electric current. We contend that the electric pressure used in the propulsion of street cars is below the danger limit. We know that a railroad operated by electricity is a pleasant railroad to ride upon. The cars are started and stopped on such a railroad easily, and without jerking. On such a railroad we do not see horses frequently struggling beyond their strength to start a loaded car or to haul it up a grade. As we ride on such a railroad, we experience a sense of exhilaration as the car swiftly and safely speeds along, and unless our attention is specially called to the trolley wire overhead, we do not even realise that it is there. Only last week many people who reside in the city of New York had an opportunity of observing some of the advantages of propelling cars by electric power under hard conditions. Those in attendance upon the Republican State Convention at Rochester indulged, in the evening after the nominations had been made, in an impromptu celebration in front of the leading hotel of that city. The street in front of the hotel was completely blocked with people listening to the speeches and admiring the fireworks. The electric cars were, however, kept moving throughout the entire evening, and as several of the lines in operation in the city passed in front of the hotel, it was necessary for the cars to feel their way through this vast crowd. During the time of the celebration between 40 and 50 cars passed through the concourse of people, moving, if need be, at a snail's pace, backing when necessary by the reversal of the current, and without in the slightest degree injuring a single person. Cars drawn by horses could not have gone through the crowd in safety. I believe that every person who witnessed that sight, no matter how prejudiced he may have been before, was convinced that the operation of street cars by electric power is safe.

There is, however, one objection, which is urged with great insistance, especially in the city of New York, to the trolley system, and that is to the trolley wire itself. There is not the slightest danger in putting up or maintaining the trolley and necessary feed wires if the work is done in a proper manner, and if reasonable care is exercised in their maintenance, except as these wires are made dangerous by the telephone, electric light, or telegraph wires placed above them. If the telephone, telegraph, and electric light companies would take as much pains in putting up and maintaining their wires as do the electric railroad companies, there would never be any occasion for complaint, so far as danger is concerned, and then the only objection which could be urged to the maintenance of the necessary wires to operate electric cars would be their so-called unsightliness.

It must be conceded that poles, however shapely, and wires, however well put up, do not improve the appearance of city streets, but quite the contrary. But experience has shown that except as poles be set and wires strung, electric roads cannot be made a commercial success, and therefore without poles and wires electric railroads will not be operated. Hence the question presented to the people of a city where the population is not large enough to sustain a cable railroad on a given line is this: Shall we have rapid transit by electromotive power and waive the sentimental objection to the maintenance of a few light wires 18ft. or 20ft. above the surface of the street, or shall we have slow transit by horse power with its many disadvantages and disagreeable accompaniments and be rid of the wires ? The question is being answered almost every day in the towns and cities of our country in favour of electric rapid transit.

The question is often asked by officials of street railroad companies who are contemplating making a change from horse to electric power, what is the cost of operation of an electric railroad as compared with the cost of operating a horse railroad ? I propose to state some experience which electric railroad companies have had upon this subject, and to answer the question as well as I can.

You have undoubtedly all seen the census bulletin prepared by Mr. Cooley, upon the relative economy of electric, cable, and animal motive power for street railways. Those of you who have seen this bulletin and studied the tables which Mr. Cooley has prepared, must have felt that, so far as electric roads are concerned, the information upon which they are based is very inadequate and unsatisfactory.

Four of the electric railroads, the reports of which furnished information for his table, had been in operation less than one year at the time these statistics were furnished, and the electric railroad which commenced operation earliest extended no further back than May 1, 1888. The average cost of operating the 10 electric railways taken for purposes of comparison by Mr. Cooley, is, round numbers, 13 cents per car mile; while the average cost of operating the 10 railways operated by animal power is, in round numbers, 18 cents per car mile; and the average cost of operating the 10 cable railways is, in round numbers, 14 cents per car mile. Mr. Cooley gives as the total average cost of road and equipment per mile of line with cable power, in round numbers, 350,000dols.; with electric power, in round numbers, 46,000dols.; and with animal power, in round numbers, 71,000dols. There is little value, however, to be attached to comparisons of this character. Everybody knows that it costs less to construct and equip a horse railroad on a given line than an electric railroad, and that it costs very much more to construct and equip a cable railroad than an electric railroad. Of course, in determining the question of economy in operation, the first cost of construction and equipment is a very important element for consideration, as well as the actual cost of maintaining and operating the railroad, whatever the motive power, when once completed. It seems more profitable to avail ourselves of comparisons which have been made by surface railroad companies operating a part of its system by electricity and a part by horse power. Fortunately, we have gone far enough in electric railroading to be able to obtain sufficient facts to enable us to make an intelligent and trustworthy comparison.

The company which has had the greatest experience as to these matters is the West End Street Railway Company, of Boston. That company has published a statement showing its earnings and expenses both with the electric and horse-car system for the months of April, May, and June of this year. I ought, perhaps, to state that as it seems to me the conditions involved in the consideration of these questions are so diverse in different cities that the only proper basis of comparison of cost of operation is the cost per car mile. It is quite common for the street railroad officials to consider this question of the relative cost of operation upon the basis of a percentage of gross receipts. It will be readily seen, however, that this basis of comparison is necessarily misleading and inaccurate. The other basis is not exact, but approaches at least approximately to exactness. The total expense, as shown by the West End Company, for motive power, car repairs, damages, wages of conductors and drivers, and all other expenses per mile run with electric power, during the three months mentioned was as follows:

	Cents.
April	21·75
May	22·36
June	20·37

The total expense per mile run with horse power, for the time mentioned, was as follows:

	Cents.
April	24·54
May	24·04
June	23·52

Earnings upon the two lines, during the period under consideration, with the two systems, were as follows:

	Cents.		Cents.
April—Electric	34·05	Horse	31·77
May— ,,	33·43	,,	34·22
June— ,,	42·71	,,	36·85

It will be observed that the earning power of the electric cars is considerably in excess of that of the horse cars, and that the expense per car mile is considerably below. The West End Company states that the electric cars of this company are run on the longer and less remunerative lines. If this be true, the showing made is very greatly in favour of the electric car from a commercial standpoint.

Permit me to refer to the experience of the company at Rochester, with which I am connected. In the month of May last the Rochester Railway Company operated 44 18ft. vestibule electric cars. The gross receipts from passengers riding on these cars during the month was 37,053.00dols., or 23·15 cents per car mile for a mileage of 159,567 miles. The total expense of operation of these cars for that month was 18,332.00dols., thus leaving a net profit of 18,721.00dols. The total cost of operation per car mile was 11·4 cents, and the profit per car mile was therefore 12·11 cents. It may be observed in passing that the operating expense was a trifle under 50 per cent. of the gross receipts.

The cost of operation was divided as follows:

	Cents.
Motive power	2·8
Car repairs	·7
Conductors and motormen	4·9
Other expenses	3

During the same period the company operated 62 horse cars, all of them without conductors. Most of the horse cars were one-horse or bobtail cars. The total cost of operating the horse cars, without conductors, during this period was about 10 cents per car mile, but the total receipts per car mile were but little above 12 cents.

In the month of June the Rochester Railway Company operated 54 electric cars and 60 horse cars. The electric cars earned each per day 23.60dols., or 22·77 cents per car mile, and the total expense of operating them per day was 10.50dols., or 11·07 cents per car mile. The cost of operating per car mile was divided as follows:

	Cents.
Motive power	2·40
Car repairs	1
Conductors and motormen	5·66
Other expenses	2·01
Making a total per car mile of	11·07

The cost of operating the horse cars during the same month per car mile was 11·06 cents, and they earned 14·37 cents per car mile. These illustrations are fairly indicative of our experience in Rochester month by month. My experience in the operation of street railroads has convinced me that the most economical system of operation is the electric system. I have not, in the statements which I have now made, taken into consideration the greater fixed charge in the operation of an electric railroad as compared with a horse railroad, due to the much greater cost of the former; but in arriving at the conclusion which I have above expressed, due consideration has been given to this element of increased cost. We know that when a horse railroad is changed over and operated by electricity, the receipts are very largely increased. It is safe in any case to say that the increase in gross receipts will be at least 15 per cent., and the average increase is probably as high as 30 per cent. Some of this increase is undoubtedly due to the greater mileage which the cars make, and still more is due to the cleaner, more rapid, and more comfortable transportation of the people.

We have reached the conclusion also that the bugaboo, which formerly somewhat frightened us, of the cost of maintenance and renewals of electric motors need frighten us no longer. We have had motors in constant service on one of the first electric lines equipped in this country—namely, the line extending from Rochester to Charlotte—and these motors seem as efficient and in every way as satisfactory as they did the first month they were operated. We have, of course, renewed various parts of the motors, and we have replaced gears which have worn out, the expense of which has gone into the cost of maintenance. But the motors are still there doing their work, and likely, with proper care and renewal of parts, to be doing their work 10, and even 20 years from to-day. The cost of maintenance and renewal of parts has not been so large as to carry operating expenses up to anywhere near the expense of operating the same number of cars, at the same mileage, by animal or cable power.

Those who propose to substitute electric for horse power will make a great blunder if they attempt to put in cheap construction or material. We who have gone into this matter have learned that the track upon which it is proposed to operate electric cars should be of girder or T rail, of not less weight than 50lb. to the yard of T and 62lb. to the yard of girder rail. The weakest place in the track is, of course, at the joint, and no cheap contrivance at that point should on any account be permitted. With girder or T rail construction it is, it seems to me, a useless expense to lay a continuous supplementary wire. The rails should, of course, be well and heavily bonded at the joints with iron, not copper wire, and cross connection of rails be frequently made. Where tram-rail track is used, I think a continuous wire should be laid and connected with the bond wires.

The overhead wire cannot be too well put up. Cheap devices should never be used because they are cheap. The best and strongest are none too good. In putting up the feed wire and putting in the ground wire return to the generators, do not spare copper. I am convinced that much that we have heard about the inefficiency of generators and motors is due to trying to get too great a quantity of current through too small a quantity of copper. In the power station, do not make the units too large. Accidents will happen as long as machinery is run, and an accident to a 500-h.p. plant is serious; while you can keep your cars, or most of them, moving if one of two or three small engines breaks down. The same rule, of course, holds as to the generators.

Always put in a condensing steam plant. One large item of expense of operation is the coal bill. Cut that down at least 40 per cent. by erecting condensing engines. The first cost is, of course, a little more, but your stockholders, as they examine your statements of operation in the years to come, will say you were wise in your day and generation.

Locate your power station as near as may in the centre of your system, but above all, if possible, on a stream large enough to furnish all the water you require for the boilers and condensers. City water, where your consumption runs into the millions of gallons fast, is expensive.

It seems to me a mistake to equip a car body of greater length than 18ft., and I think a 16ft. car is better still. During the hours of the day when travel is heavy, it is easy to pull a trailer, and when traffic is light, you are not then using up your power in hauling around a great lumbering double-truck structure practically empty.

A great many companies have had trouble with their motors. The chief reason for this trouble has been that their motors have been too light mechanically and too economically built electrically to stand the strain. All the manufacturing companies have learnt their lesson, and to-day most of the motors put upon the market are strong enough mechanically and electrically to perform, under proper conditions, the work expected of them.

The managers of electric roads, if they are to be made successful, must learn that the greatest earning power is no excuse for extravagant management, and that the difference between success and failure is often a narrow one. Everything depends upon taking the stitch in time. A loose belt, an imperfect connection, any one of 40 little things, may result in serious damage and consequent financial loss. I do not know of an electric railroad anywhere where the overhead single-trolley system is used which ought not to be successful. I know of some which have not been. In some cases cheap construction accounts for failure, and in some others careless management or reckless extravagance is the cause of the failure. The scrap heap about an electric car barn or machine shop often tells a significant story. In intelligent supervision and painstaking watchfulness is found one great secret of commercial success in this business, as well as in most others.

Every manager should keep a record of the items which go to make up operating expenses, and those responsible for management should carefully study these statements month by month with a view of lessening the expense of each item. An intelligent and careful examination of the cause of accidents to parts of a motor will often be the means of preventing the recurrence of troubles in the future.

So far as possible, motormen, as well as conductors, should be made to understand the mechanism of the machines which propel their cars and the function of each part. Thereby they are made ready to act promptly and intelligently in case of trouble with a motor.

The directors of some companies, because of their desire to make handsome returns to their stockholders, have paid out in dividends money which ought to have gone back into the road. The proper policy to pursue in all cases is the building up and bettering the plant out of earnings, so far as necessary, even at the expense of cutting down dividends.

The field in which we are working is a great one. There is in this field abundant opportunity for the intelligent, progressive, and sagacious business man. The primary object which the management of a street railroad seeks to attain is business success, but success in that direction cannot be had without great resulting benefits to the people of the community served by the railroad operated. We should not lose sight of the fact that we are engaged in a work the successful performance of which builds up communities, aids business enterprises, and makes the life of the people in those communities better worth living.

JOHN N. BECKLEY, Committee.

COMPANIES' MEETINGS.

BRUSH ELECTRICAL ENGINEERING COMPANY.

The second annual general meeting of this Company was held on Friday afternoon, September 25, at Cannon-street Hotel, the Duke of Marlborough presiding.

The **Secretary** (Mr. B. Broadhurst) having read the notice convening the meeting, and the report having been taken as read,

The **Chairman** said: It is a somewhat difficult position that occupy here to-day, having assumed the chairmanship of this Company for what I may call a broken year. I have had the pleasure of being connected with this Company now for, I think, three years. I have watched its progress, and seen the difficulties it has had to contend with. When we, unfortunately, lost the valuable services of our late chairman, Lord Thurlow, the Board were kind enough to ask me to carry on the business of the Company, as chairman, for the remainder of the year—and that duty I was very pleased to accept. Personally, perhaps, it is a fortunate circumstance for me that I am able to bring to your notice so favourable a balance-sheet as the one now placed before you. It is some—in fact, many—years since this Company has been able to feel that its position was one of what I may call commercial stability. The history of your Company is a peculiar one. As you are aware, it has been in existence for about 12 years—it was founded in 1879—and at that time there was an idea that the electric light was going to sweep all the gas companies straight away, and, in fact, completely revolutionise the conditions of our time and our industries. That anticipation was not fulfilled. We found out—as electricians could have told the public at the time—that hundreds of problems still remained unsolved, and that, not only with regard to the production of electrical energy, but also with regard to its distribution, it would take years before this industry (electric lighting) could be placed upon a commercial basis. In the inception of your affairs you had many valuable patents; those patents you sold for large sums, and your dividends were enormous. One year you absolutely paid a dividend of over 100 per cent. But it was not to be supposed that such a state of things as that could exist without turning men's heads, and making them go beyond the limits of prudent enterprise. The consequence was that in a very few years the Brush Company got into considerable difficulties, and Sir Henry Tyler, the then chairman, resigned. At that time Lord Thurlow became the chairman, and it really was a terrible time to have undertaken the chairmanship and the direction of the affairs of the Company. Not only were there the great difficulties occasioned by the discouragement which had been created by the failure of early promises, but there was the extraordinary difficulty which arose from the character of the early Electric Lighting Acts. These were of such a nature that when electric lighting came to be brought into a business position it was impossible to capitalise undertakings, there being no security to shareholders that they would not be bought out at a price that would leave them nothing for their money. To amend the Electric Lighting Acts was quite an undertaking. Your late chairman, Lord Thurlow, in conjunction with other gentlemen, was very largely instrumental in getting them amended, and in getting the present Acts passed. It is owing largely to these Acts that the electric lighting industry is possible in this country in the form of public lighting. We therefore owe our late Chairman a great debt of gratitude for having somewhat unobtrusively worked this matter through in the House of Lords, and for having carried on the affairs of this Company through four or five years of considerable depression—a time when we were unable to pay any dividend. And so matters went on until, as you are aware, it was necessary to bring about a reconstruction of the Company. It had become necessary in 1884 to reduce the share capital by writing off a portion of it, and it was found necessary to combine the Australian business with our own. Lord Thurlow was largely instrumental in bringing about this reorganisation. This, and the amendment of the Electric Lighting Acts, was the turning-point in the affairs of the Company. The object of this Company is not to do small, or what I may call retail work, but to carry out large industrial enterprises. Electrical energy has many features and many sides of usefulness. There is electric traction and electric mining—in fact, there are various ways in which electrical energy can be employed, but the principal reason for the existence of your Company is the developing of electric lighting centres. Now you are going to have gradually, and by slow degrees, an immense demand for the establishment of large electric light companies. What the gas companies did in former times the electric light companies are going to do in the future, and, therefore, there is a large field of industry open for such a Company as ours. In order to be able to carry out that work, your Directors decided that it would be very desirable to obtain some large manufacturing premises, and negotiations were carried out by which you obtained the Falcon Works at Loughborough. The Directors have visited these works, and agree in reporting to you that you are possessed of very splendid manufacturing works, where you can make dynamos and engines on a large scale; in fact, on as large a scale as any works in this country. They have been begun in a conservative spirit, but I am sure that as our industry develops you will approve of those works being extended. The peculiar feature of your enterprise to-day is that you are looking forward to acquiring large and important orders for carrying out electric light in important centres, and that you possess the Falcon Works, where you can manufacture plant to carry out those enterprises. Our policy, in fact, has been to concentrate our energies, and to get rid of outside obligations. I will mention something as to this later on. But at the present moment I will turn my attention to one or two small features of the report placed before you. Another of your Directors (Mr. Braithwaite) will speak presently on the subject of the accounts, and will analyse for you the particularly favourable character of the figures financially. The only point that it is my duty to insist upon is that this balance-sheet includes nothing except that which is fair honest trading profit for the year. No profit from the City undertaking has been carried into this year's report, nor any profit from the sale of the Bournemouth station, nor the moneys received on account of the sale of the strip of land to the South-Eastern Railway. There is nothing more than a trading account, showing that you have made this year gross profits of £39,915, as compared with £36,698 for the year 1889-90.

And this brings me to speak of the City undertaking. Shareholders, I think, do not all realise what an extremely important thing this is. Probably, there is no undertaking in the whole of Europe at the present time which affords an exact parallel to the one you are concerned in carrying out. This is the only city, so far as I am aware, in which the whole of the private and public lighting has been entrusted to one big company (the City of London Electric Lighting Company) for a period of 40 years' monopoly. Just consider what is the condition in other parts of London where provisional orders have been granted, and you will at once see what the advantage is. In other districts the Board of Trade has been paramount, and there it has decided to give two orders for each district—one for the continuous-current system, and the other for the alternate-current system. That is undoubtedly in the long run going to create confusion and disappointment to shareholders. What will happen is this. One company will start with one system, and when they have gone a certain way towards lighting the district another company will put down another system, and then there will be competition, but not fair competition. It will be a competition of trying to bounce one system by threatening it with the competition of another. The reason why this is not fair is that the streets of London do not admit of laying two systems of cables under them. When one has been laid you cannot find room for another system. Now, you have nothing of that sort here in the City. You have a perfectly clear field. There can be no competition so long as the Company carries out its work properly. You have a monopoly. We are interested in this business to the extent of two-thirds. The district is divided into three parts, and we have two parts. A group of gentlemen who are representatives of an American firm of some position (the Thomson-Houston Company), have obtained the other portion. If the City of London Company succeeds in carrying out its work satisfactorily, and avoiding the mistakes which, unfortunately, were made in earlier enterprises, you will get all the credit of that success; and that must eventually lead to the development of the central lighting business, which, as I have said, is the main feature of our industry. I really cannot impress upon you too strongly what an immense advantage it is to you to have obtained this valuable order, and in passing I cannot help saying that you ought to know that you owe that entirely to the persistent labour and energy of our managing director, Mr. Garcke. Although the Board give every attention to your affairs, it would have been impossible for them to have negotiated this enterprise without Mr. Garcke. He worked at it for several years, and succeeded in carrying it out. It is largely owing to his successful labours that we are able to come forward and make such a very favourable report, not only with regard to the balance-sheet, but also with regard to the Company generally. The next point is as to Bournemouth. It was considered advisable to establish a business here for the purpose of demonstrating what the electric light could do. There was so much ignorance in former times with regard to the electric light, and it was so necessary to push this industry, that we have been very much puzzled at times to know what policy to adopt. At a certain period in the history of the affairs of your Board it was considered advisable to push the industry at Bournemouth, and to obtain a provisional order there. This was done, and the Company carried on the work themselves. In the opinion of your Board, however, it was unsatisfactory for a manufacturing company to be placed in this position; and we thought it was more advisable to realise if we could the values there locked up, and place ourselves in a freer position. Negotiations were set on foot which ended in successfully floating the Bournemouth company, and the terms of that business were not all unprofitable to us. We reaped a fair profit on our plant, and we have taken over our profit partly in the form of shares and partly in cash, the amount being £17,275, so that you are free from any difficulties or engagements with regard to Bournemouth, and the matter is now in the hands of a local board, composed of gentlemen who have got local interests, and have the energy and determination necessary to make the business succeed. The capital of the company is £30,000, and your Company has guaranteed a 5 per cent dividend on that capital for a period of three years. I don't think, judging from the returns at Bournemouth and the demand there is for the electric light, that you are really incurring any risks by giving that guarantee. I now go on to another feature of the report, and that is our business at Vienna and Temesvar. At one period it was considered advisable to acquire the Vienna business. This was done at a very cheap price, and a great deal of time and energy has been devoted to developing it. We have a factory there which was of a temporary character, but has now been increased by permanent works, which are nearly finished. A large business is being done there. Temesvar is a place something like Bournemouth. We undertook the lighting of that town and we are still carrying out that business, but negotiations are going on both with regard to the Temesvar affair and the Vienna factory, which are likely to end in your Company disposing of those industries on favourable terms. There is a great deal to be said against "long-armed" management; that is, managing an industrial enterprise abroad from London, especially at such a distance as Vienna. In a case like this you cannot manage an industry like the electric light as successfully as people on the spot, especially in a country like Austria. I have therefore no hesitation in saying that if an arrangement can be carried through financially advantageous to you, by which you can dispose of these two businesses, it will be a wise and prudent course to take. I have only one or two other matters to touch on. One is the South-Eastern Railway. Negotiations went on for a long time with regard to the sale of a portion of the ground on which our Lambeth works are situated. These have resulted in an agreement having been made for the sale of a strip of that land to the railway company. That agreement and sale have been carried through. Unfortunately, selling that land has interfered with some of the offices of the Company, and we have therefore been obliged to take offices for the Board and for the financial department at the corner of Queen Victoria-street, opposite the Mansion House Station. Here there is, as I daresay you have noticed, a shop belonging to the Company, where there is a large exhibit of our plant. Meanwhile, the works at Lambeth remain as they were, so far as the technical and draughtsmen's offices are concerned. I now come to the question of Australia. As you know, you have a branch business there, and a great deal of trouble and thought has been devoted by the Board, and also by your Managing Director, to the development of this industry. We have a manager there, Captain F. Rowan, who does all he can to develop our interests on that side of the world. It might seem that there was not a great deal to be gained just at the present by establishing such a branch of our industry, and yet when we think of it we must see that it cannot be our colonies that will develop this new business, unless we go in first and start it. No doubt the colonies will require these things, which we can provide, and which they cannot. Although there is not much demand at present for electric lighting there is a satisfactory demand springing up, and the business is a growing one. In a few years' time you may hail with satisfaction the fact that your Board were inspired with the idea of getting early into the Australian field, and obtaining the custom of our cousins on the other side of the world. Though the profit on the first year's working is not much, it affords an indication of what the business may become. I, therefore, look forward with hope to the development of a considerable business in Australia and the colonies in the course of the next few years. With regard to the development of this wondrous invention (electric lighting) during the last 10 years, engineers, men of business, and the professors have all practically come to the same conclusion that we now know exactly where we are moving. It is simply, therefore, a question of expense. When the public can afford to put up the money to form companies for the lighting of their towns by electricity, we, the Brush—and other companies, too—are absolutely in a position to solve the problem for them. There is no doubt about that. Ten years ago, when the Company paid its 100 per cent. dividend, we were not in that position. To-day you are an industry established on an essentially conservative basis. Your Directors do not recommend that it should be pushed or boomed in any way; but they feel the greatest confidence that it is simply a question of time and expense, and then we shall be able to get any quantity of orders. We require to do good and remunerative business, not cheap work. I feel no hesitation, therefore, in speaking in the most hopeful way with regard to the future. I may say, in passing, that as compared with the average of the five years preceding the reconstruction of the Company, the volume of business has increased in the ratio of 100 to 288—that is, very nearly 200 per cent., while the standing charges have only increased in the ratio of 100 to 113, or, say, 13 per cent. The policy of the Board has been to keep down as far as possible the standing charges. So that you will observe that I am right in saying that our policy has been an essentially conservative one. I will conclude by saying that you have before you every prospect of a successful year, and I hope next time we meet to be able to present quite as successful and prosperous a report as the one before you to-day. You are aware that not only have we lost the services of Lord Thurlow as chairman, but we have also lost, I am sorry to say, the valuable services of Mr. John Sellon, who was so long connected with this Company. He was unable, however, owing to his many engagements, to continue to give his personal attention to the affairs of the Company. It is my duty now to move that the report of the Directors and the statement of accounts to the 30th June, 1891, as now presented to the shareholders, be received, and the same are hereby adopted.

Mr. J. B. Braithwaite, jun., in seconding the adoption of the report, said that he entirely endorsed what the Chairman had said as to the balance-sheet being a purely trading one. There was not one penny of the profits made or to be made in connection with the City of London order included in it. These were all in store for them in future years, and he thought they might look forward with satisfaction to future balance-sheets. One great change in this year's balance-sheet, which had been carried out at the suggestion of the auditors, and was a wise one, was that a separate balance-sheet had been got out of the foreign and colonial business. On the debit side their capital had been increased by the sum of £5,000, which was the remaining payment they had to make to acquire the Australian business. Then there was an item on each side of the balance-sheet in connection with the City of London business. On the debit side £34,892, which represented money received from the Pioneer Company and other sources; and on the other side £21,070, which at the date of that balance-sheet they had actually expended in the City of London work. He was very glad to see on the debit side the beginning of a reserve fund (£4,275), though it was very small at present. It was a portion of the cash they had received for the sale of property to the South-Eastern Railway Company and other sales. It would be the policy of the Board to increase that reserve as opportunity offered. The property account had been largely reduced, as compared with last year, and the details were given in the report. Turning to the profit and loss account, they would see on the credit side that their gross profit, including a profit on foreign and colonial branches, amounted during the year to £39,915, and that in spite of the fact that their Managing Director and officers had had a good deal of their time taken up with the City business. On the debit side they would see that the standing charges had been reduced as compared with last year. Every item almost showed a reduction. A new item appeared under the head of staff bonuses, £759. He hoped they would all agree with the policy of the Directors in this matter. It had been to give to every officer in the Brush Company, and ultimately they hoped to every man employed, an interest in the Company. In fact, they had adopted a profit-sharing scheme, and so far as it had gone they had every reason to be satisfied with it. They commenced by placing all the chief officers on that scheme. Then they were able to extend it by electing another series of them, and this year they would be able to extend it still further—viz., to all the foremen, and possibly to some of the men who had been longest with them. When they considered that the quality of their manufactures depended upon the individual care of the workmen on small pieces, it was not only right as a policy of justice to the men, but it was a good policy as affecting their own (shareholders) interests. To show how honest the balance-sheet was, he would call attention to the fact that, in addition to paying the dividend (6 per cent. on the ordinary shares, for which £7,018 had been appropriated), they had appropriated out of net profits for the year other items of an equal amount. This would show that if they had had any disposition to submit a false balance-sheet they could easily have done so. They had written off £3,000 against property, and £630 against preliminary expenses. Then they carried forward a balance of £306. Against revenue they had written off the whole cost of the maintenance of their plant and buildings. They had written off the whole cost of maintenance of patents and the whole of the loss incurred in closing their Cardiff station. The closing of this station was not because it did not answer, but because the Corporation would not consent to the Company getting a provisional order, and the Board of Trade refused to allow them to carry on the lighting without one, so they had no option but to close the station. If the Corporation should ultimately decide to undertake the lighting of the town, they might come to the Company. It was not unlikely. These items amounted to another £7,045, so that they had written off against revenue an amount equal to that which they had distributed in dividends.

Mr. Smart objected to the wording of the paragraph as to dividends. Instead of 6 per cent. per annum for the half-year, it should be 3 per cent. for the year. He also contended that instead of lumping property, patents, and goodwill, etc., into one sum, property should be separated from goodwill and patents. He pointed out that after all the business that had been done, the gross profit was only 9 per cent. on the turnover of the Company.

Mr. Weir, as an original shareholder in the Brush Company, expressed his satisfaction at the condition of the Company. They appeared to have passed the experimental and to have arrived at the producing stage. He was glad they had adopted the profit-sharing scheme, and would congratulate the Company on having Mr. Garcke for a managing director. He asked if any progress had been made in the way of electric traction for tramways and light railways, and was their machinery adapted for such railways as were being constructed by the Government in the West of Ireland?

The **Chairman**, in reply to the questions, said, as to the dividends it was a matter of personal liking as to how the wording went. As to the gross profits being only 9 per cent. on the whole capital of the Company, the concern had gone through very considerable vicissitudes, and they must remember that that capital, which would eventually earn a dividend, had been spent in building up the industry they now possessed. They had had heavy litigation and mistakes. But the industry promised to grow, and as it grew, it would carry all the money that had been spent in acquiring the experience they now had. The ratio of 9 per cent. would increase, and they would have less capital expenditure and larger returns. As to the property patents and goodwill item, that represented something that had been taken over by them from the old company *en bloc*. It was a bargain they had made, and they might as well put it down as one item and stick to it. They were very anxious to develop electric traction. They were carrying out one contract in Spain which they hoped would be a success. Mr. Mordey, one of their technical staff, had only lately returned from America, and had brought over details as to what was going on there. A large demand was likely to grow up for electric tramcars in outlying districts. The Falcon Works was originally a car-making concern, and this feature had been preserved, and they made cars there. They were going to try and obtain orders for tramcars and light railways in the future. He then put the motion adopting the report, and declared it agreed to.

The **Chairman** then proposed the declaration of a dividend of 6 per cent. on the preference shares, and 6 per cent. on the ordinary shares (*vide* report, p. 287 of our issue for the 18th September), payable on the 1st October, which was seconded and carried.

Mr. Van Tromp proposed the re-election of the Duke of Marlborough and Mr. Saunderson as directors, which was carried unanimously, as also was a motion for the re-election of the auditors, Messrs. Cooper Bros. and Co.

A vote of thanks to the Chairman concluded the proceedings.

CITY OF LONDON ELECTRIC LIGHTING (PIONEER) COMPANY.

An extraordinary general meeting of this Company was held at Winchester House, E.C., on Wednesday afternoon, the Lord Mayor (Sir Joseph Savory, chairman of the Company) presiding, to consider the question of voluntarily winding up the Company.

The **Secretary** (Mr. J. Cecil Bull) having read the notice convening the meeting,

The **Chairman** said it was his duty to tell them that the object for which that Company was formed had now been realised, and they had sold the concern to the City of London Electric Lighting Company for the sum of £75,000, clear of all deductions. He thought this must and would be satisfactory to the shareholders, and he felt no doubt that they would unanimously pass the resolution which was intended to be placed before them. Any questions that any shareholder might like to ask he would be very happy to answer. No questions being asked, his lordship said that he would formally propose that the Company be wound up voluntarily.

This was seconded by **Mr. J. B. Braithwaite, jun.**, who thought they would be fairly well satisfied with the result of their investment in the Pioneer Company, and still more satisfied that they had succeeded in their object, which was to form a company which should undertake the efficient lighting of London. Their company stepped into the breach last February and initiated the proceedings, and the financial arrangements for the lighting work having been made he had only to congratulate the shareholders on the fact that the formation of the City of London Lighting Company had been successfully carried out. The shareholders would receive back the money they had embarked in the Company, with a bonus of 50 per cent. (Each shareholder receives his original capital of £50 per share with a bonus of £25.)

The resolution was carried unanimously.

The **Chairman** then said that he had only to add that the extraordinary general meeting confirmatory of the one he was addressing, would be held in about a fortnight, and the cheques to the shareholders would be made out as soon as possible after that meeting.

Mr. Edward Lee proposed a vote of thanks to the Chairman and Directors for their services, remarking that it had been mooted about that lord mayors had no right to put their names on prospectuses, or even to become directors of public companies. But that was an exceptional case. The Lord Mayor, as head of the City, did what he could to aid the Board of Directors of this Company, which was for the benefit of the entire City of London.

Mr. McGeagh seconded the vote, and it was carried unanimously.

The **Chairman** said he was extremely obliged for the vote on his own and his colleagues' behalf. It was his firm resolution when he entered on his public office to join no company, and it was only exceptional reasons, and pressure brought to bear upon him from very high quarters, that induced him to so far waive his resolution as to join that Company. He could assure them it was a satisfaction to be able to announce that the work they had in hand had advanced so far satisfactorily, and that they had so far protected the interests of their shareholders.

DIRECT SPANISH TELEGRAPH COMPANY.

The thirty-sixth ordinary general meeting of this Company was held on Tuesday at Winchester House, E.C. Mr. Edmund Etlinger presided, in the absence of Sir James Anderson, who has recently sustained a severe domestic bereavement.

The **Chairman** observed that the statement in the report, that the receipts showed a decrease of £1,620 as compared with those of the June half of 1890, did not quite do justice to the position of the Company; and proceeded to explain that the receipts for the half-year under review had been larger than they had been in any similar period since the beginning of the Company in 1873, with the sole exception of last year. The shareholders might, therefore, be satisfied that the Company was in a very sound and healthy position. With regard to the future, he had no doubt that the volume of their traffic would keep on increasing; but last year the Paris Telegraph Conference again reduced their tariff, and they had been working under the lower rate from the 1st of July last A message from London to Bilboa was now transmitted by the Company in three minutes, while a message from London to Madrid was transmitted in 20 minutes. Considering that the message had to go overhead from London to Falmouth, under water from Falmouth to Bilbao, and overhead from Bilbao to Madrid, he thought that that was remarkably good work. That appeared to be the opinion of others also, for people in Paris occasionally sent messages to London to be transmitted to Bilbao by the Direct Spanish Cable, and sometimes telegrams were despatched from Paris to London to be transmitted by the Direct Spanish Company to Madrid, although there was a direct wire from Paris to Madrid. Their cables, instruments, and property generally were kept in good order, and their Manager and staff did their work admirably. With the exception of the interruption to the Barcelona cable from the 3rd to the 14th of April, their cables and the land lines in connection with them had continued in good working order throughout the half-year. Excepting the actual "kink" where the break referred to occurred, their Barcelona cable, which had been under water since 1874, was found in perfect mechanical condition, and they might, therefore, hope that it had a long time before it, and that they would not have much to expend on it in the future. They owed their best thanks to the Eastern Telegraph Company for their promptness in placing one of their repairing ships at this Company's disposal, the result being that the interruption only lasted 11 days. The cost of the repairs—£1,695—had been paid out of the contingencies account—a fund which had been started to meet any expense, such as that which had occurred this year, without trenching on the reserve fund. Out of the balance of profit they had transferred £2,500 to the reserve fund; and, after providing for the debenture interest and the dividend at the rate of 10 per cent. on the preference shares, they recommended a dividend on the ordinary shares at the rate of 5 per cent. per annum, leaving a balance of £270, which they proposed to carry to the contingencies account, although it was quite true that by appropriating this sum to dividend they could have recommended 6 per cent. per annum on the ordinary shares. The present moment, however, was—he would not say critical but one requiring great consideration and forethought. It was impossible to say yet how the reduced tariff would affect them, and the only way they could recoup themselves was by getting an increase of traffic, while that was a matter over which they had no control. With regard to the working since the 1st of July, they had carried considerably more words than in the same period of 1889—he again left out 1890—but the additional traffic had not quite compensated them for the loss of ½d. a word.

The resolution was seconded by **Mr. J. Denison Pender** and passed, the dividends recommended being approved.

Subsequently a resolution expressing sympathy with Sir James Anderson and his family was carried.

CITY NOTES.

Brazilian Submarine Telegraph Company.—The receipts for last week amounted to £4,915.

Western and Brazilian Telegraph Company.—The receipts for last week, after deducting 17 per cent. payable to the London-Platino Company, were £3,833.

Callender's Bitumen, Telegraph, and Waterproof Company.—An interim dividend of 5s. per share, payable on October 31, has been declared by the Directors.

City and South London Railway.—The receipts for the week ending September 27 were £708, against £684 for the week ending September 20. The total receipts for the month ending September 27 were £2,727.

Anglo-American Telegraph Company.—The Directors have declared an interim dividend for the quarter ending September 30, 1891, of 12s. 6d. per cent. on the ordinary, and £1. 5s. per cent. on the preferred stock, less income tax, payable on October 31.

The Eastern Telegraph Company announce the payment on 15th inst. of interest of 3s., less income tax, being at the rate of 6 per cent. per annum, on the preference shares for the quarter ending September 30, and the usual interim dividend of 2s. 6d. on the ordinary shares, tax free, in respect of profits for the quarter ended June 30.

PROVISIONAL PATENTS, 1891.

SEPTEMBER 21.

15953. **Electropathic massage, appliances therefor and for other purposes.** James H. Barry, 56, Leadenhall-street, London.

15980. **An improved form of carrier for shades and globes for gas and electric light.** Joseph Grace Smith Cunnington, Keats' Cottage, John-street, Hampstead, London.

16006. **Improvements in electrical insulators.** William Henry Radcliffe Saunders and William Griffiths, 22, Southampton-buildings, London.

SEPTEMBER 22.

16038. **Improvements in telephonic receivers which may also be used as transmitters.** Alexander Marr, 70, Market-street, Manchester.

16076. **Automatic coin-freed telephonic machine.** Josef Wratitsch, and Stefan Gergacsevics, 37, Chancery-lane, London.

16080 **Improvements in governors for dynamo-electric machines.** Mahlon Smith Conly, 45, Southampton-buildings, London. (Complete specification.)

16087. **Improvements relating to electrical traction.** John Howard Furman, 6, Bream's-buildings, London.

16090 **Improvements in telegraph posts.** William Pitt, 24, Southampton-buildings, London.

16091. **Improvements in electric circuits for lighting and other purposes.** William Henry Massey, 24, Southampton-buildings, London.

16099. **Method of and apparatus for converting the electrical energy of alternating currents into mechanical motion.** Charles Schanck Bradley, Robert S. Taylor, and Ronald Trevor McDonald, 1, Queen Victoria-street, London (Complete specification.)

16110. **Improvements in or connected with automatic regulating devices and in electrically actuated pointer mechanisms applicable therefor, and for other purposes.** William Phillips Thompson, 6, Lord-street, Liverpool. (The firm Willing and Violet, Germany.)

16113. **Improvements in suspenders or hangers for electric lamps, applicable also for other articles** Thomas Henry O'Brien and Charles O'Brien, 6, Bank-street, Manchester.

16119 **Improvements in electric switches.** John Bonham Carter, 53, Chancery-lane, London.

SEPTEMBER 23.

16130. **An arrangement to regulate the potential of dynamos.** Frank Edward Beeton, 72, Tytherton-road, Tufnell Park, London.

16181. **Improvements in electric signalling apparatus, chiefly designed for police service.** Horace Everett Walter, 45, Southampton-buildings, London.

SEPTEMBER 24.

16205. **A meter for telephonic and other purposes.** Matthew Cranswick Greenhill and John Ronald Shearer, 8, Romola-road, Tulse Hill, London.

16250. **Improvements in dynamo machines.** Robert Hammond and Charles James Hall, 433, Strand, London.

16270. **Improvements in or appertaining to accumulators for the storage of electric currents.** William Phillips Thompson, 6, Lord-street, Liverpool. (Erich Correns, Liverpool.)

SEPTEMBER 25.

16293. **Improvements in the method of and in the means for propelling ships and other vessels electrically.** William Edwin Heys, 70, Market-street, Manchester. (Jean Jacques Heilmann and Felix Drouin, France.)

16300. **Improvements relating to electrical fittings.** Charles Scott Snell and Woodhouse and Rawson United, Limited, 88, Queen Victoria-street, London.

16312. **Improvements in electric crane hoists, etc.** Dennis Grenville Shephard and Norcliffe George Thompson, 13, Victoria-street, London.

SPECIFICATIONS PUBLISHED.

1890.

13921. **Electric lamps.** Schanschieff and Sando. 6d.

14349. **Electric meters.** Siemens Bros. and Co. (Siemens and Halske.) 8d.

14433. **Coin-freed electrical apparatus.** Ford-Lloyd. 8d.

15464. **Governing electric light engines, etc.** Sullivan and others. 8d.

17631. **Electric accumulators.** Lauber. 8d.

1891.

11075. **Electric meters.** Mills. (Pilkington and White.) 8d.

13070. **Telegraph, etc., posts.** Dymond. (Bourdon.) 8d.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Brush Co.	—	3½
— Pref.	—	2
India Rubber, Gutta Percha & Telegraph Co.	10	19½
House-to-House	5	5
Metropolitan Electric Supply	—	10½
London Electric Supply	5	2¼
Swan United	3¾	5⅝
St. James'	—	8½
National Telephone	5	4⅜
Electric Construction	10	7¼
Westminster Electric	—	6

NOTES.

Palermo.—The exhibition at Palermo opens on the first of next month.

Electric Railway at Baden.—A concession has been granted to Ganz and Co. for an electric railway from Baden to Voslau.

Lectures.—Mr. Gisbert Kapp is to give three lectures before the Royal Engineers at Chatham on "Alternating Currents."

Brussels Post Office.—The contract has been awarded for lighting the general post office at Brussels. Tudor accumulators are to be used.

Electric Pump.—Mr. Van Depoele has applied his newly-constructed reciprocating electric motor to driving pumps as well as coal-cutters.

Factory Lighting.—The Maidstone jam factory is being fitted up with the electric light apparatus by Messrs. R. Dann, of High-street, Maidstone.

City Lighting Company.—Colonel Ben Hay Martindale, C.B., has been elected a director of the City of London Electric Lighting Company, Limited.

Telegraphs in Mashonaland.—The Chartered Company has just forwarded 114,000lb. of telegraph wire to complete the telegraph to Fort Salisbury.

Telegraph Poles.—Tenders are required for red fir telegraph poles for the Post Office. Forms can be obtained of the Controller of Stores, Telegraph-street, E.C.

Rochdale.—Extensions are intended to be made of the Rochdale Gas Works. Such an advanced town as Rochdale has often shown itself should have the electric light.

Siemens Electric Railway.—It is announced that Messrs. Siemens and Halske will construct an electric railway at Chicago on the model of their very successful line at Budapest.

Hotel Lighting at Torquay.—The electric light has been fitted at The Falcon Hotel, Torquay, by the proprietor, Mr. J. W. George, who is thus the pioneer of electric lighting in that town.

Newspaper Office Lighting.—The offices of the *Daily Chronicle* are being fitted throughout for the electric light by Messrs. Paterson and Cooper. The dynamos will be running by the middle of next month.

Oerlikon Works.—Mr. C. E. L. Brown, so long associated with the Oerlikon Company as chief engineer, ceased his connection with the company at the end of last month. His present address is Baden, Switzerland.

Telephone Exchange at Gravesend.—The Gravesend Town Council are in negotiation with the National Telephone Company with the object of introducing an efficient system of telephone into the Gravesend district.

Continuous-Current Transmission.—The transmission from Offenbach to Frankfort by means of the Lahmeyer continuous-current system, first made at 1,250 volts, has now been raised to 2,000 volts, and has proved very successful.

Omnibus Lighting.—In another column will be found an advertisement from the London General Omnibus Company asking for tenders for the supply of electric hand lamps. This is an interesting departure, and we hope will prove a success.

Chicago Exhibition.—The World's Fair power plant will be of 24,000 h.p., and will require the services of 250 engineers, firemen, and attendants. Contracts have been let for the machinery hall (1,200,000dols.) and electricity hall (375,000dols.).

Steam Loop.—The invention of the steam loop for economising steam, worked by the Steam Loop Company, of Leadenhall-buildings, is coming into practical use. Tests recently carried out by Prof. Kennedy have given very satisfactory results.

Swiss Water Power.—It is stated that owing to the extensive development of electrical transmission of power, and the consequent rise in the value of water power, that all motive power from water in Switzerland will be made a Government monopoly.

Holborn.—At the Holborn Board of Works on Tuesday, the surveyor said, in answer to a question, that he did not think it would be advisable for the Board to put in installations for electric light unless they were allowed to supply private people also.

Electric Light on Dredgers.—The trustees of the Clyde Navigation propose getting a dredger of the most powerful class, with all modern improvements, fitted with an installation of electric light on board so as to provide for working night and day when desired.

Accrington.—It was reported to the Accrington Town Council on Monday that the advice of a very eminent electrical engineer had been sought with a view to the laying down of plant for supplying electricity for lighting the borough, and that a report would be presented shortly.

Renewable Cut-out.—A cut-out which automatically replaces a new fuse when one is burnt out, is being introduced by Messrs. Nuis and Vail, of New York. A rotating drum with the several wires on its surface is so arranged as to turn round and insert a new fuse when a burn-out occurs.

Electricity in Agriculture.—M. Delétrez having experimented with the application of electric currents to the growth of the beetroots used for sugar, states that the excitation provoked by the current at their first growth, causes increase of vital energy, and stimulation of organs, greatly favouring the development of a fine species.

Tenders for Bournemouth.—At the Bournemouth Town Council meeting on Tuesday, the General Purposes Committee recommended, and it was resolved, that advertisements be issued inviting schemes for lighting the pier and garden by electricity, and that such schemes be afterwards submitted to an expert to report and advise upon.

Hospital Lighting.—As a further proof that the advantages of the electric light for hospital work are now fully appreciated, we learn that Messrs. Drake and Gorham are engaged in wiring the St. George's Hospital, the current being used to light the operating theatre and other places where the light is required, and also for cautery and other purposes.

Tramway Concessions at Galatz.—The mayoralty of the township of Galatz (Roumania) being desirous of making a concession for the construction of a tramway line in the town, notify those who may wish to undertake this matter that they may see or obtain the conditions and terms at the Mayoralty. Tenders will be received from Nov. 15 to 27.

Trowbridge.—The advisability of introducing electric light into Trowbridge is being discussed, and a canvass of the inhabitants has been taken. It is mentioned that engines are lying idle in the town sufficient to supply 800 lights, which is quite sufficient for a beginning, and it has been proposed to rent and utilise these by the Local Board as a committee.

Liverpool.—Councillor E. Purcell was to have moved at the meeting of the City Council on Wednesday, "That the Watch Committee be instructed to consider and report to the Council as to the advisability, best method, and probable cost of using the electric light in lieu of the present mode of lighting the city." The motion was, however, left over.

Dover.—At the meeting of the Dover Town Council on Tuesday, it was decided to adopt the electric light, a provisional order for which was obtained from the Board of Trade a short time ago. The agreement with the Brush Company details of which were given in our issue of September 18th, was accepted. A local company will be formed, with a capital of £50,000.

Owens College.—The Principal of Owens College, in his statement of the work of the past year, mentioned that the total number of day students was 811, evening students 425. Amongst the prizes awarded, that in Electrical Technology was awarded to Mr. Bertram Sands Giles, whose prize paper on "Recent Progress in the Science of Magnetism" we give in the present issue.

Consulting Electrical Engineers. — Mr. Morgan Williams, A.M.I.C.E., M.A., formerly installation engineer to the Electrical Power Storage Company, and the Electric Construction Corporation, has now entered into partnership with Mr. Frank King, M.I.E.E., and the firm are practising as consulting electrical engineers, under the title of Messrs. Morgan Williams and King, at 39, Victoria-street, Westminster.

Electric Launches on the Ship Canal.—The Manchester public will soon have at their service three electric launches running between Manchester and Barton. These launches have already become popular on Lake Windermere. They will be similar to those used in connection with the Edinburgh Exhibition, which conveyed 100,000 passengers during the season along the canal from Edinburgh to the exhibition.

Barnet.—The affair at Barnet is not yet over. The Board wish Mr. Joel to remove his posts, but the contract says the contractor "may remove" the posts—not "must remove" them; and Mr. Joel does not wish to do this, at least until the arbitrators have inspected the plant. A motion was put and carried at the last Board meeting that the poles must be removed within a month or the Local Board would remove them.

Opera by Telephone.—The telephone has now been definitely installed between one at least of the Paris hotels and the Grand Opéra. The charge is 50 centimes (5d.) for five minutes. An amateur who tried it last week states that he heard a good deal of "Lohengrin" in this manner. A lady with him was, however, unfortunate enough to take her turn at the telephone during an entr'acte, whereby, of course, she wasted her money.

City Lighting.—At the meeting of the Commissioners of Sewers on Tuesday, the clerk read a formal notice from the City of London Electric Lighting Company of the assignment to them of the provisional orders and agreements by the Brush Electrical Engineering Company and the Laing, Wharton, and Down Construction Syndicate. The communication was simply for the information of the court, and it raised no comment.

Burton-on-Trent.—At the monthly meeting of the Burton Town Council on Wednesday, the Gas and Electric Light Committee reported the receipt of 16 tenders for lighting a portion of the town with electric light. Alderman Lowe pointed out that it would be necessary for exhaustive enquiries to be made before the committee made any definite recommendation. For the present the light would be an expensive luxury, and would probably cost more than they had indicated.

Electric Light and Poachers.—A curious and novel use for the electric light has been found. It can be employed for the detection of poachers. The gamekeepers on an estate near Bournemouth found that poachers were in the preserves, and by the aid of occasional flashes from the search-lights at Hurst Castle, which are very powerful, they were able to recognise two men, who ran away, leaving behind them a net 100 yards long.

Electric Trams for Birkenhead.—The Finance Committee of the Birkenhead Corporation have had under consideration a letter from Messrs. Francis and Pierce, solicitors, applying on behalf of the Birkenhead United Tramways, Omnibus, and Carriage Company, Limited, for the permission of the Corporation to the introduction of electrical motive power on the tram lines leased by the company from the Corporation. The matter was deferred.

Sevenoaks.—The electric lighting movement at Sevenoaks does not appear to make much headway, and now the Board of Trade propose to the Local Board that the provisional order obtained by the Electric Trust, Limited, shall be revoked, this being the result of a previous communication received by the Local Board from the Trust asking the Board to agree to the renewal of the order for another year. The Board have not as yet taken any action in connection with the Board of Trade's proposal.

Lisbon Opera House.—The Portuguese Government, says the Lisbon *Times* correspondent, has declined to continue to pay for the electric lighting of the Lisbon Opera House, which amounts to over £6,000 a year, or to contribute towards any other system of lighting. The Government never was under an obligation to pay for the lighting as it has done hitherto, and it is stated that the electric method is being found too costly, while the laying down of gas-pipes would amount to a still greater sum.

Halifax.—A report has been presented to the Council meeting by Mr. J. H. Woodward, of Wolverhampton, with respect to the construction and working of a central station in Halifax for supplying the electric light. The report proposes to locate the central station at the late Salvation Army Barracks, Stead-street, and that it should be worked by steam power. The estimated capital outlay is put down at £52,594; and the estimate of running expenditure at £7,508. 5s. per annum. The report will be found in another column.

Walsall Electric Tramways.—The directors of the South Staffordshire Tramways Company having decided to introduce the overhead trolley system of electric traction, have invited tenders for the reconstruction of the plant from the Electric Construction Company (Wolverhampton), the Brush Electric Company, Crompton and Co., the Thomson-Houston Company (America), and several other companies. The work will, it is hoped, shortly be taken in hand, and it is anticipated that the electric cars will be in working order in about six months' time. The current will not exceed 500 volts pressure.

Overhead System at Edinburgh.—The Lord Provost's Committee of the Edinburgh Town Council had before them last week a letter from Mr. R. Addison Smith on the subject of the erection of a temporary overhead electrical system in Leith-walk, with the view of showing the Corporation and the tramway company that tramcars can be worked on steep grades by electricity, and also with the view of obtaining data as to the cost of driving. A report by the burgh engineer on the subject was read, and the committee resolved to recommend the Town Council to decline to give their sanction to the proposal.

Projected New Submarine Cable.—A submarine cable will shortly be laid between Pernambuco and Senegal. The project, says Dalziel, is being promoted by an English company, and, unless unforeseen difficulties arise, it is announced that within six months the cable will be open for traffic. Dom Pedro, when in power, was earnestly in favour of extending the trade relations of Brazil with the countries of the West Coast of Africa. This project will now be carried out by means of the new cable and a service of steamers between Pernambuco and Senegal. There is reason to suppose that the trade of Africa with South America will be largely increased.

Edison's Latest.—Edison has apparently "invented" another electrical application (not altogether unknown already for some time past to engineers on this side) in a method for driving tramcars without trolleys or storage cars. So, at least, the *Daily News* informs us with a sceptical flourish of trumpets. The electricity is to go by one rail and return by another, the difficulty being not to short-circuit the two rails. He has had a railway running in his village, and intends, so it is said, to apply it shortly in New York. It would seem to be a closed-conduit system, a method for some time in practical though tentative operation in this country by Lineff and Gordon.

Electric Lighting of Bray.—The whole of the town of Bray, known as the Brighton of Ireland, is to be lighted by electricity. Messrs. J. E. H. Gordon and Co., Limited, of 11, Pall-mall, have secured the contract, and have put the work in hand. The principal streets are to be lighted by arc lamps and the rest with incandescent, and the mains for the supply of current for private houses will be laid at the same time. The electricity will be generated by water power situated in the town. The system to be used will be the same as that which Messrs. Gordon are carrying out at the Crystal Palace—namely, direct current, with motor transformers and storage batteries.

Electric Plans in Belgrade.—The French Under States Secretary Gaze has been visiting Belgrade, and along with him the Parisian contractor Perrichon. These well-known gentlemen, says *Kuhlow's Review*, have given a concession for the electric lighting of the town to a Mr. Trikos; in addition, there is to be a street car run by means of the same agency. The work for both plans has been already commenced. MM. Gaze and Perrichon intend to draw up a French-Servian Company, which will include the above-mentioned plans as well as others for canalisation, etc. Judging from previous attempts, there is considerable doubt entertained as to the success of the undertaking.

Electric Transmission at Marburg.—An electric transmission of force is contemplated by a mill owner of the name of Franz, in Marburg. He intends collecting the different water power employed by the mills on a mountain stream in St. Lorenz, which lies about 20 miles from Marburg, and will then conduct the force, amounting to 600 h.p., by means of electricity to Marburg. The force thus obtained will not only turn his corn mill, but will also be conducted into several workshops and there made available. The cost of the undertaking has been estimated at about £22,000. It is calculated that if only 400 h.p. be obtained, the outlay would be made good in from 12 to 15 years.

Saint-Cyr.—The military college of Saint-Cyr—the French Sandhurst—was lighted in 1889 by order of the Minister of War by electric light, which took the place of the 1,185 gas jets with which it had hitherto been lighted. The current, furnished by two dynamos of 500 amperes and 75 volts, supplied both incandescent and arc lamps. The latter, with positive carbon at the bottom, is covered in by a reflector, and the light is reflected on the ceiling. The illumination by this means is so uniform that a pencil placed upright on a piece of paper throws no shadow in any direction. The good results obtained on the first trials determined the administration to establish the electric light throughout the whole building.

New Electrical Machine.—At the beginning of the year the late Prof. Edmond Becquerel had presented to his classes of *Arts-et-Metiers* a small apparatus invented by his demonstrator, M. Peignot, in which a new method of generating static electricity was employed. This method consists in forcing mercury by means of a pump through the pores of chamois leather. The friction generates a considerable quantity of electricity, which is easy to collect, manifesting itself in sparks. M. Ducretet has built an instrument embodying this principle. The machine forms a handsome column 40in. high and 10in. in diameter. The new electrical machine does not appear to have much practical bearing, but as a scientific novelty is certainly interesting.

South London Railway.—The additional engine and dynamo for the South London Electric Railway are now completed, and will be erected during the next few weeks. They are made by the same contractors as before; the engine by Messrs. Fowler and Co., of Leeds, and the dynamo by Messrs. Mather and Platt, Salford. A few modifications are made in the arrangement of valves and so forth in the engine, with reference to the great and sudden changes of load that take place on this line, otherwise the additional set are the same as the three at present in use. The extra machinery has been found desirable, not so much to give additional power—two of the present set being more than ample for present needs—but to provide a spare engine always ready to be thrown on at a moment's notice, a condition not possible at present when one of the engines happens to be under repair.

The Glasgow Electrical Engineer.—Mr. William Arnot, who was elected some weeks ago to the post of electrical engineer to the Glasgow Corporation, has entered upon his duties within the past few days, but until the Town Council Committee on Electric Lighting have resolved what they will do in the way of practically applying the terms of the electric lighting provisional order, it does not seem that there can be much work for him to do. Something definite may be resolved upon after the committee have had their long-desired conference with Sir William Thomson, which is to be held this week. What the committee are going to do will largely depend upon the result of the negotiations now in progress between that body and Messrs. Muir, Mavor, and Coulson, Limited, for the acquisition of their central lighting station, machinery, plant, goodwill, etc., by the Corporation.

Aberdeen.—Mr. Evelyn Liardet, whose scheme for the lighting of Aberdeen by electricity generated by water power was recently mentioned, has written to the Gas Committee making an important offer. The committee, it may be remembered, decided not to take up the idea meantime; but Mr. Liardet, convinced of the practicability of his plan, has offered to purchase and fit up Kettock's Mills, from which ample power could be obtained for generating the light; provide the machinery, and set it in motion, so as to provide 4,000 lights for the city, on condition, in the event of the scheme proving a success, that the Council should take it over and arrange on equitable terms what should be paid to him. All risk would be taken by him in the event of the scheme not proving satisfactory. The committee appointed a sub-committee, consisting of Bailie M'Kenzie and Bailie Nicol, to further consider the matter.

Alternate-Current Electric Railways.—We mentioned some time ago the project which was being taken up by Mr. Westinghouse for the use of alternating electric currents for tramway work. The subject has recently been taken up by Mr. Elias E. Ries, whose experiments on increasing the friction of railway wheels electrically will be remembered. Mr. Ries proposes to use high-tension alternating currents in closed conduits under the track, and on the car to have transformer coils to utilise the induction and give low-tension currents for driving alternate-current motors. The induction from a single line will be utilised. The method involves the use of magnetic screens in the primary towards the earth, and a free inductive field upwards towards the car. A method such as this, if practicable, would certainly simplify the track. Particulars of Mr. Ries's venture will be received with interest.

High Speeds and Electric Motors.—The project of running ordinary railway trains by electricity is gaining many strong adherents in the States. Prof. Thurston, the great authority on friction, says: "The assumption seems fair that the locomotive engine will have been superseded when we double our speeds, and that we must find ways to utilise the weights of the cars themselves for adhesion and to make each to carry its own motor." No less an authority than the general superintendent of the New York Central and Hudson River Railroad Company, Mr. John M. Toucey, is stated to believe "that in less than 10 years electricity will take the place of steam on railroads. He will not be surprised to see, in less than that time, the largest and swiftest trains on the Central railroad controlled exclusively by electricity, and run with a speed equal to, if not greater than, that of the present day." Such convictions expressed by such authorities should cause railway engineers to think.

Proposed Exhibition at Glasgow.—The Glasgow Corporation Electric Lighting Committee have declined to recommend the Town Council to give their patronage and moral support to an electrical exhibition which it has been proposed to hold, in connection with the Wild West show and other entertainments, on the ground and within the premises occupied by the East-end industrial and fine art exhibition last winter. The patronage was asked by Messrs. Russell and Peyton, who call themselves the "joint managers of the Glasgow Bellevue Gardens Company." As that concern is not publicly known in Glasgow, and seems to exist only on paper, it would have been passing strange if the request preferred by the persons named had met with anything else but a refusal from the Electric Lighting Committee of the Town Council. The proposal to hold an electrical exhibition under such strange auspices as the Wild West show has excited no local interest whatever; indeed, it is questionable if any of the local electrical engineers know anything about it.

Manchester Electric and Hydraulic Station.—The Manchester City Council had before them on Wednesday the joint report of the Water Works and Gas Committees with reference to the purchase of a site for a station for hydraulic and electric engineering. The engineers are Dr. Hopkinson for the electric, and Mr. Woodall for the hydraulic engineering. Alderman Sir John Harwood, in moving the report, said both hydraulic and electric power were much required. The only question was that of site. He suggested that the committee should settle the question themselves. No doubt ultimately another station for hydraulic power would have to be erected near to the Ship Canal docks; but in the meantime, in his opinion, the Gloucester-street plot was the best for the first experiment. It would be economical to have the stations for both hydraulic power and electricity together, for the same machinery would do for both purposes, as the electric light would be needed at night and the hydraulic power in the daytime. The motion was carried.

Cuba.—An extensive arc and incandescent plant has been installed in Havana by the Spanish-American Light and Power Company. A small plant erected some three years ago proved inadequate, and the present one was projected, with a capacity of 500 arc lights and 8,000 incandescents. The boiler-room is fitted with four Hazelton Porcupine boilers of 150 h.p., and three 150-h.p. boilers of another make from Baltimore. The engine-room has the following engines, all in line: Four 150 h.p., three 100 h.p., three 75 h.p., Armington and Sims; one 150 h.p. and one 75 h.p., Westinghouse. The Westinghouse engines exhaust into separate Worthington condensers. The Armington and Sims engines exhaust into the feed-water heaters and pass into an underground canal to a brick chimney 150ft. away from the station. The dynamos are placed in one long room, and are as follows: Five 1,500-light alternating-current Westinghouse, each self-excited; one 750-light 2,000 volt alternating-current Westinghouse; ten 50 arc light 1,200-c.p. Thomson-Houston dynamos.

Liverpool Technical Evening School.—On Saturday evening a specially-built evening technical school was opened in Liverpool. The premises, which are of four storeys, are situate near the Walker Art Gallery. The building is 121ft. long and 21ft. wide. The front view is of classic aspect. The vestibule leads into a long corridor, from which are the entrances to the physics department, the electrical laboratory, the engineering department, and the staircase leading to the drawing and brickwork and masonry department. The electrical laboratory is 67ft. by 18ft., having a concrete floor and roof lights and being fitted with working benches, masonry piers for galvanometers, accommodation being provided for about 30 students doing practical work. The lecturer in this subject is Mr. J. Lloyd Barnes, Whitworth scholar, and the instruction consists of an hour's lecture in an adjoining room, after which students proceed to the laboratory for practical work. The classes in physics, which embrace the subjects sound, light, and heat, magnetism and electricity, will also be held under Mr. Lloyd Barnes in the physics lecture-room, which adjoins the laboratory, provision being made for a full experimental treatment of these subjects. Owing to the liberality of Mr. Henry Tate, the committee will now be enabled to complete the electrical laboratory by putting down an electric light installation for experimental work, which will very materially add to the educational value of the institution. Engineering classes, modelling classes, and plumbers' workshops have also been arranged, besides classes on photography, drawing, and mathematics. The building sub-committee, who have been instrumental in designing the arrangements, consisted of Messrs. J. W. C. Haldane, Henry Duckworth, T. Gee, and Dr. Gustaf Schack-Sommer, and they have acted under the advice of the various teachers.

Torquay.—At the meeting of the Torquay Local Board last Friday, the Electricity Committee reported that the surveyor had submitted to them an exhaustive and well thought-out report on the subject of a proposed installation of electric light at the Bath Saloons, and the question of the lighting of the town generally. From this report the committee gathered that it would not be possible to carry out the idea of lighting the Bath Saloons by means of electricity generated by the present mechanical powers there; and they deemed it would be unwise to recommend the Board to incur any expense to enable this to be done at present. Neither would it appear to be expedient to think of utilising the water from the Board's water works for the purpose of working machinery in connection with any proposed supply of electrical energy on account of the cost, and uncertainty of water power being always available and regularly obtainable, either at the storage reservoirs or in the mains. With regard to advising the Board as to the course which should be followed in exercising the powers conferred upon them by the provisional order, the committee reported that they were not prepared to do this at present. They felt that in deciding upon such an important matter as the electric lighting of the town, which would necessarily involve considerable expenditure, it was desirable to proceed cautiously, considering it highly important that the Board should have before them the fullest information on the question, particularly in regard to the best modern practice. The committee asked the authority of the Board to their making enquiries as to the expense, and if thought desirable of obtaining the opinion of an expert or electrical engineer respecting the surveyor's report, and to advise them on the subject generally. Dr. Richardson moved the adoption of the report. It was thought better to consult a specialist than to send a deputation to a number of other towns, and after some discussion, the resolution was carried.

Ozone.—MM. Labbé and Oudin recently communicated to the Academy of Sciences some interesting observations on the action of ozone, of which the *Lancet* gives an abstract: "The action is best observed when the subject is placed in conditions which approach as nearly as possible to the natural production of the gas. When prepared chemically the ozone is found to be always more or less impure; consequently, for experimental purposes, it is best prepared by the electrical method. This can be easily carried out by passing a current of air between the two tubes across which the electrical discharge is to be made to pass. In this way an animal may be made to inhale air containing $\frac{1}{11}$ to $\frac{1}{12}$ of a milligramme of ozone per litre without the least inconvenience. When the blood of an animal, which averages usually from 10 to 11 parts per 100 of oxyhæmoglobin, has been examined after the animal has been submitted to the inhalations for a quarter of an hour, an augmentation of one in 100 is found, and this is constant. A highly interesting point is the observation recorded by the authors on the action of ozone on tubercular cultures. Two tubes containing these cultures were submitted to ozonic influence for some time, and then some of the fluid was injected into the cutaneous tissues of two guinea-pigs. Two other guinea-pigs were at the same time inoculated with another portion of the tubercular preparation which was not submitted to ozonic action. Now these latter animals succumbed to acute tuberculosis within 25 days, whereas the former two showed nothing abnormal as to their condition of health 50 days after the experiment. Ozone has, moreover, according to these observers, another therapeutic property hitherto little, if at all, noted, and which, in their opinion, may lead the way to some important results—viz., its power of displacing and transporting the metallic substance of the electrode; and they found that this molecular displacement took place with all the metals."

Protector for Surfacemen.—An ingenious and simple instrument has been devised by Sir Wm. Arrol, for the protection of surfacemen at work on the railways. He was led to apply his mind to this matter in consequence of the numerous fatalities which have lately occurred among that class of railway servants. The instrument consists of a steel spring connected with a portable electric battery and bell by a coil of wire from 200 to 300 yards long. The spring is 3in. broad by about 18in. long, and is fixed at one end to a sole-plate, which may be readily bolted by means of two clips to the inner side of the rail. The free end of the spring has an upward curve, and is so arranged as to be almost flush with the top of the rail. When the spring has been bolted into position the battery is carried to the neighbourhood of where the workmen are engaged, the connection being kept up by the coil of wire, which is unwound to the necessary length. When a train comes along the spring is depressed by the flanges of the wheels as they pass over, and two metallic buttons, one on the under side of the spring and the other on the upper side of the sole-plate, are brought into contact, and complete an electric circuit supplied from the battery, and ring the bell at the battery, thus warning the workmen of the approach of the train. The intention is that these instruments should be kept at the signal-boxes along the line, so that the workmen might get them handily. Already the invention has been submitted to the leading officials of the North British Railway Company, and they have expressed themselves so favourably of it that they are likely soon to have some in operation. It has also been submitted this week to the Caledonian and Glasgow and South-Western Companies. Sir William does not intend to patent the invention. His sole desire is to render the surfaceman's life a less dangerous one, and if the railway companies approve of the invention they are at liberty to manufacture as many as they please. The cost for each instrument complete is roughly calculated at about 50s.

Gulcher Thermopile.—The improvements in the Gulcher thermopile, now being exhibited in the Frankfort Exhibition, consist chiefly in the employment of a positive electrode consisting of an alloy of antimony not easily fusible, and very durable; further, in the use of nickel as negative electrode, and in an arrangement for preventing the overheating of the place of junction. The remarkable feature of this thermopile is, in addition to its great durability, its great efficiency, greater than has hitherto been obtained by any similar apparatus. The model shown in operation at the exhibition has an E.M.F. of four volts and a current of five amperes, at a consumption of 200 litres of gas per hour. The working expenses are, therefore, about one farthing per hour. It will thus be seen that the Gulcher thermopile per cubic metre of gas gives a total electrical energy of 100 watts, whilst the best apparatus of this kind hitherto constructed only gave about 24 watts per cubic metre of gas. A still higher efficiency than the batteries heated by gas is shown by the batteries intended for production of large electrical energies and arranged for heating with coke. In these the elements are grouped round a common stove, and other improvements have been adopted to increase the efficiency. A thermopile constructed after this principle and consuming two kilogrammes of coke per hour gives 80 volts and a current of 10 amperes. A battery of this description would suffice for feeding eight glow lamps of 16 candles continually, or, with the help of accumulators, 30 of these lamps for six hours per day. Such a battery, it is stated, would supply light for a house of moderate size, and not only light but also heat, by placing, for instance, the stove in the basement and heating the house by hot-air pipes. The smaller type of this interesting apparatus is already in the market, and constitutes an excellent generator for electroplating, chemical, and physical laboratories, for charging accumulators, for working electro-medical and dentists' apparatus, for replacing galvanic batteries in telegraphy and telephony, and other purposes. The larger type is being tested for its durability, and is shortly to be brought into the market. The apparatus is manufactured by Julius Pintsch, of Berlin.

RECENT PROGRESS IN THE SCIENCE OF MAGNETISM.[*]

BY B. S. GILES.

The nineteenth century has been pre-eminently marked by the most wonderful and rapid advances in all branches of science. Its history records searching and indefatigable enquiry, accompanied or followed by startling revelations and brilliant success.

Probably no two branches have shown more rapid development than electricity and magnetism, and, indeed, it seems quite natural that the newest sciences will have the quickest growth, not only because there are more workers in the field, but also because the principles, and the known facts, and the best instruments of the older sciences can be applied to their investigation. At the beginning of the century electricity and magnetism were hardly worthy to be called sciences. Although a few facts were known about each, scarcely any of them had a rational explanation, and they were demonstrated and dismissed as very interesting and curious phenomena; the attachment of the probable physical interpretations, has been reserved to physicists of the last few decades.

Now these two branches are so closely connected that it is difficult to deal with one without frequent reference to the other, because among the most famous and useful discoveries in them have been those proving the intimate relations which exist between them, such as Faraday's discovery that when a closed coil of wire is made to move in a magnetic field, so as to alter the number of lines of force which thread through the coil, a current of electricity is set up in it; and the equally important discovery that the strongest magnets are made by passing electric currents round iron cores. But in spite of this close connection, the state of magnetism may, as far as our limited knowledge goes, exist independently of any state of electrification or of the energy of the electric current. Whether or not this is so, the consideration of the recent progress in the science of magnetism alone is sufficient for our present attention. In what follows, I purpose to give first a brief *résumé* of the work which recent experimentalists have done, and afterwards specially to discuss the theories which have been advanced to account for the phenomena observed.

About 60 years ago, Faraday commenced those researches which indicated his extraordinary aptitude for original work, and which have since made him famous; but his attention was at first confined chiefly to electrical investigations, and it was through electricity that he first studied magnetism, in consequence of the connecting link which exists in the electromagnet. Before this, very little had been done, beyond some experiments made in 1822, by Barlow, on the magnetic action of iron between red and white heat, closely followed by Christie's investigations, in 1825, of the effect of temperature on magnetising forces.

In 1838, Gauss made the first determinations of the horizontal component of the earth's magnetism, and the value and accuracy of his methods are shown by the fact that they are still employed and called by his name. The earth's magnetism has, ever since the realisation of its existence, been a source of much enquiry and speculation; for many years the compass needle was almost the only practical application of the magnet, and in consequence of this, and its great value for purposes of navigation, it received a large share of attention. The diurnal, annual, and secular variations have also been the objects of numerous observations, and it is rather surprising to find what a great deal has been published from year to year in this direction. Indeed, except for the publication of these tables of statistics, the science of magnetism would appear to have been at times neglected for years consecutively.

Passing rapidly over the interval between 1830 and 1855, the record of Faraday's "Researches" might almost be regarded as a history of the science during this period. The great investigator seems to have been always in advance of his times, and he and a few of his contemporaries who might be mentioned, such as Ampère and Arago, gave to the world what are now regarded as fundamental principles. In 1845, Faraday examined the action of magnets on light, especially on the polarisation of light, and in the following year turned his attention to diamagnetism, but does not seem till a few years later to have formed any idea of magnetic resistance, which is so necessary in accounting for this phenomenon. In 1851 he examined the action of gases placed in magnetic fields, and found that oxygen is decidedly paramagnetic, and that its paramagnetic force decreases with temperature. He accounted for diurnal, annual, and secular variations by the constant variation of the elements, and especially by changes of temperature caused by the sun. At the same time he began to entertain clear views of "lines of magnetic force," and even went so far as to indicate that they must always form closed curves. At first he brought forward this conception as a hypothesis, but afterwards expressed his strong belief in the physical existence of these lines. Being essentially an experimentalist and not a mathematician, the quantitative treatment of the science Faraday wisely left to others.

Wiedemann, in 1861, related his discovery of the magnetism which an electric current produces in an iron wire, and, besides much other good work, brought out a treatise of sterling merit, entitled "Galvanismus."

Three years later Clerk Maxwell showed what an essential part the medium plays in all magnetic effects. Till the untimely close of his life, this original and deep thinking mathematician supplemented in a wonderful manner the practical work of Faraday and others, and there can be no doubt that Faraday by his "Experimental Researches," and Maxwell by his publications, have largely influenced the work and modes of thought of nearly all subsequent experimentalists and theorists.

In 1866, Wilde built his first dynamo, and soon afterwards Wheatstone introduced the principle of self-excitation in these machines, but the next 10 or 12 years show very little progress except in the manufacture of dynamos, which from that time till the present have been made in great variety, and have undergone very rapid improvements.

A great revival, and one which has been the means of much enlightenment in the theory and general effects of magnetism, took place about 10 years ago. A new generation of investigators in this branch had arisen, foremost among whom must be mentioned Ewing, Hopkinson, Hughes, and others.

Sir William Thomson, who has perhaps been concerned more with electricity than with magnetism, in 1879 made a very thorough investigation of the effects of stresses on the magnetisation of iron, and this has subsequently been studied by Ewing, Tomlinson, and others.

In the same year Shettle demonstrated the obliquity of the axes of bar magnets, and two years later Hughes confirmed his results by finding that a natural magnet can be produced, having its molecular arrangement of a spiral form.

Hughes had by this time brought his ingenious instrument, the induction balance, to a state of great perfection; and in spite of many who at first failed to see its practical utility, though admiring its ingenuity, he used it with good effect to investigate the molecular conditions of magnetism, and in 1883 formulated a theory of these physical conditions, basing his results almost entirely on researches made with his balance. He also found that the magnetic capacity of iron or steel is directly as its softness or molecular freedom, and that its resistance to a feeble external magnetising force is directly as its hardness or molecular rigidity.

In 1881 Ewing discovered the very important phenomenon to which he gave the name of hysteresis. He was led up to the consideration of it by "the production of transient electric currents in iron or steel conductors by twisting them when magnetised, or by magnetising them when twisted."[*] He conceives that the combined effect of torsion and of longitudinal magnetisation is to produce a state in the wire which persists almost unchanged when the magnetising force is removed. He found that the change of state "lags behind" the change of torsion, and it is this lagging behind to which he has applied the name hysteresis. The subject has occupied his attention more or less ever since, and his enquiry into it has certainly been very exhaustive.

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[*] Being the paper which gained the prize in the Owens College Physical Laboratory.

[*] *Proc.* Roy. Soc., 1881.

Moreover, in 1885 he found that there is not only static hysteresis, but also a small amount of "viscous lagging," "time-lag," or "magnetic creeping" in the changes of magnetism which follow changes in magnetising force, and he considers that the great difference in the amount of this time-lag which exists between a single thick wire and a bundle of fine wires of the same material, is explained by the fact that the creeping itself sets up eddy currents which are more numerous in the solid than in the laminated bundle, and that these eddy currents react so as to retard the creeping.

As an illustration of "time-lag," I may mention some effects observed in experiments made at the Salford Iron Works, which I am permitted to refer to.

The primary object of the experiments was to measure the waste field of a few different sizes of Manchester and Edison-Hopkinson dynamos, by finding the ratio of the total number of force induced in the magnets to the number passing through the armature core. As they all more or less illustrate the point in question, I have selected the figures of one machine only—viz., a No. 6 A Manchester dynamo with an armature core 13¾in. diameter.

The Manchester dynamo, being of the double horseshoe pattern, with a ring armature, 12 convolutions of wire were taken round the middle of each magnet limb, and the two coils joined in series; two diametrically opposite sections of the bare core were likewise wound each with 12 convolutions, and the two coils joined in series, and the core placed in the fields so that the maximum number of lines of force passed through the coils. If the free ends of the coils be connected to a ballistic galvanometer, the throws obtained on suddenly magnetising and demagnetising the magnet limbs are proportional to the induction, and the ratio of the throws obtained from the magnets to those obtained from the armature is the ratio required. The object of using so many convolutions was only to obtain a large deflection, and to make the direct action of the field on the galvanometer small in comparison to the throws obtained from the coils.

The field was suddenly made with 100 volts across the magnets, and suddenly short-circuited, alternately, by means of a hatchet switch, this being found the best way of ensuring instantaneous change.

A reversing key was used so that the deflections could always be read in the same direction, and the connections were arranged so that the small direct action of the fields should oppose the throw on making and assist it on short-circuiting, which is equivalent to breaking.

Now this experiment has been made previously by Drs. J. and E. Hopkinson* and others, but the statement has generally been made that throws on make and break will be equal.

I found, however, that the make was always greater than the break, as the following figures show, in spite of the fact that the direct action of the field was to oppose the make and help the break. If this be allowed for by adding a small quantity to the former and substracting the same quantity from the latter, the effect is more marked.

(1) Magnets connected—

Make = 567 divisions.	Break = 504 divisions.
Make = 576 „	Break = 506 „
Make = 580 „	Break = 508 „
Make = 582 „	Break = 510 „
Mean make = 576.	Mean brake = 507.

(2) Armature connected—

Make = 388 divisions.	Break = 308 divisions.
Make = 398 „	Break = 307 „
Make = 382 „	Break = 310 „
Make = 403 „	Break = 317 „
Mean make = 393.	Mean break = 310.

The direct action of the field was to move the needle 20 divisions during the time of the first swing of the magnet throws, and 15 divisions during the armature throws.

The final values thus become:

Magnet make = 576 + 20 = 596.
Magnet break = 507 − 20 = 487.
Armature make = 393 + 15 = 408.
Armature break = 310 − 15 = 295.

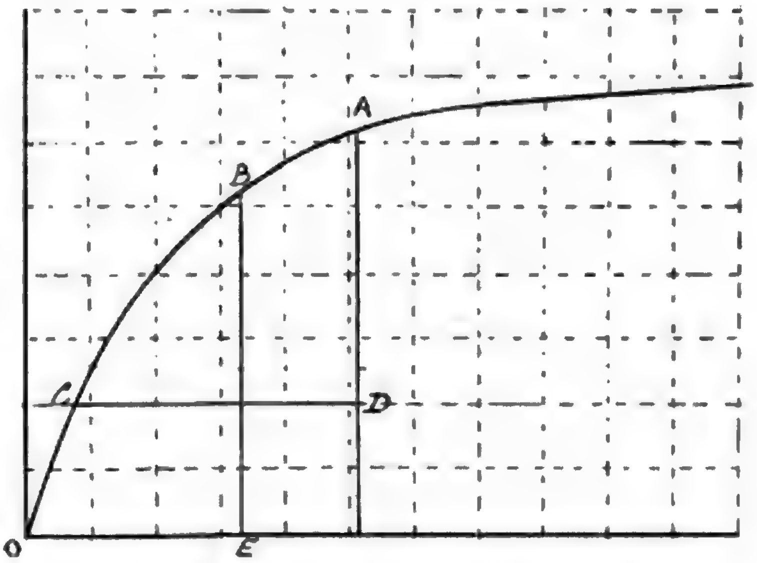
$$\text{Ratio required} = \frac{596 + 487}{408 + 295} = 1{\cdot}54.$$

This means that out of every 154 lines of force which pass through the magnets, 100 pass through the armature.

It occurred to me that this well-marked difference between make and break might possibly be due to the "time-lag" observed by Ewing.

If the characteristic curve of the dynamo were a straight line, then in spite of hysteresis and time-lag the make would always be equal to the break, but inasmuch as we are working on the bend of the curve the former is greater than the latter, and the stronger the field employed the greater will the difference become.

The conditions might be represented diagrammatically thus:



Suppose that with 100 volts across the magnets we are working on the part of the characteristic curve marked A. Then, on suddenly breaking, the induction will not at once fall to 0, but in the time during which the needle completes its first swing will fall, say, to some point, C, and A D will be proportional to the throw. On again making, the induction will not at once rise to A but to a point, B, such that the arc O B = the arc A C, and B E will be proportional to the throw, so that the ratio of make to break will be the ratio of B E to A D.

In the relation of change of magnetisation to temperature, Ewing found that there is no hysteresis, the reason possibly being that change of temperature cannot take place without vibration of the molecules, but he observed well-marked hysteresis in the effects of stress on the thermo-electric quality of iron. The similarity of the plotted curves in this case to those which illustrate the hysteresis exhibited in the effects of stress on the magnetisation of iron suggest that the former effect is secondary to the latter.

This possibility occurred to Ewing, who immediately proceeded to investigate it. His experiments conclusively proved that stress does not affect the thermo-electric quality of iron by first producing a change in its state of magnetisation, though any magnetism present modifies the result, and that therefore the hysteresis of thermo-electric change is quite distinct from the hysteresis exhibited in changes of magnetisation, though perhaps both are assignable to the same peculiarity in the molecular constitution.

Warburg had discovered that the area enclosed by the ascending and descending curves of magnetisation in a complete cycle is a measure of the energy expended in producing the cycle. Ewing soon independently realised this fact and expressed the energy quantitatively. The amount of this energy turned out to be a much smaller quantity than some had supposed, and his experiments led him to a very important practical conclusion. It had been suggested that, assuming the loss of energy due to mere reversal to be considerable, a great saving might be effected by building the armatures of dynamos without cores, but Ewing was able to point out that since the energy expended in mere reversal is very small in amount in soft iron, the power absorbed in the armature is due, first to the loss in the coils due to the main current, and, second, to eddy currents developed in the core and in the coils, and, therefore, if soft iron is used and thoroughly laminated, the efficiency will not be less than in an armature without a core. As a matter of fact it will be much greater, because of the great increase of waste field when cores are dispensed with.

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* *Phil. Trans.*, 1886, p. 339.

Ewing at about the same time entered very fully into the question of retentiveness, and found, contrary to the generally accepted opinion before, that soft iron is much more retentive than hard iron or steel when quite undisturbed; but that vibration has an enormous effect on the retentiveness. It was probably this action of vibration, in causing iron to lose its residual magnetism, which led to the erroneous impression that retentiveness varies directly as the rigidity of the molecules.

Ewing lays great stress on the importance of the absence of all mechanical disturbance, as he found that even a light footstep in the corridors adjacent to the rooms in which he experimented was sufficient to make a very great difference in the residual magnetism of soft iron.

He summarised the results of his experiments on the ratio between residual and induced magnetism as follows:

"When the induced magnetisation is very weak, it almost all disappears on the removal of the inducing force.

"When it is increased, its capability of being retained also increases very rapidly, and the ratio of residual to induced magnetism reaches a maximum.

"The value of the maximum is from 0·84 to 0·93 in annealed iron, nearly as great in annealed, hardened, or tempered steel, but much less in hard-drawn iron, where its value is more like 0·6. . . .

"As the magnetisation is further increased, the residual magnetism approaches saturation more rapidly than the induced, and consequently the ratio diminishes—slightly in soft iron, more in steel, and much more in hard-drawn iron."[*]

He even goes so far as to say that he thinks very soft iron might, under certain theoretical conditions, possess perfect retentiveness.

During the last three or four years nickel has received a greater share of attention. Of course this metal is not nearly as interesting as iron from a practical point of view, nor is there room for so much investigation in it; but, nevertheless, the study of it and of cobalt is very helpful in forming a true conception of the real physical nature of magnetism.

In 1888, Ewing found that longitudinal pull reduces both induced and residual magnetism in nickel, and that, as Sir William Thomson had pointed out as possible in 1879, longitudinal compression has just the opposite effect.

The converse of these physical processes was investigated by Shelford Bidwell. He found that the length of iron is increased up to a certain critical value of the magnetising force, when it reaches a maximum; beyond this value the elongation is diminished, and if the force is further increased the iron regains its original length and eventually undergoes retraction. I believe no explanation has yet been offered of this subsequent retraction. In the case of a nickel bar the length is diminished by magnetisation from the beginning.

Bidwell's first experiments were made on rods. As doubts had been expressed about the value of some of his results, in consequence of some of the means which he employed, he substituted rings for the rods, and with many improvements on his original apparatus confirmed his previous conclusions.

We will now glance briefly at some of the work done and conclusions arrived at by Dr. John Hopkinson.

In 1886 he selected for investigation the effects of impurities on the magnetisation of iron. His results are very instructive, particularly those on the effects of small quantities of manganese on the electrical and magnetic properties of iron. He found that the introduction of only 12 per cent. of manganese renders iron non-magnetic, and pointed out that the manganese must be regarded as entering the molecules of iron and completely changing their properties.

He examined the effect of a large number of other foreign bodies on iron, and concludes by saying that we are a very long way from obtaining a range of facts sufficiently extended for testing a complete theory of magnetism.[*]

In 1889 he published the results of some very careful investigations of the magnetism and general magnetic properties of iron at high temperatures, from which it appears that when a small magnetising force is employed and kept constant, the magnetisation of iron steadily increases with rise of temperature, till it begins to approach the "critical temperature." Just before this temperature is attained the magnetisation increases very rapidly, but as soon as it reached and exceeded the iron loses very nearly all its magnetism, and can be thoroughly demagnetised by employing a very high temperature, but even then the iron regains some of its original magnetism when subsequently cooled. The "critical temperature" varies from 690deg. C. to 870deg. C., according to the quality of the material.

He also found that "regarding the iron as made up of magnetic molecules the axes of which are directed to parallelism by magnetic forces, the magnetic moment of the molecule diminishes with rise of temperature, at first slowly, but very rapidly as the point is approached at which magnetism disappears. On the other hand, the facility with which the molecules are directed continually increases at first slowly, but at high temperatures very rapidly. The effect is that at a temperature = 720deg. C., an exceedingly small force is competent to turn the axes of nearly all the molecules in a direction parallel to the magnetising force."[†]

I think this last effect is just what might be expected as the iron approaches to the condition of a fluid, and seems to be a continuation of the fact that soft iron is much more susceptible to induced magnetism than hard iron.

Dr. Hopkinson here points out two distinct and opposite effects of increase of temperature. Probably if the effect on the magnetic moment were to increase it instead of diminishing it, enormously powerful magnets could be produced by first heating iron to nearly the critical temperature, and saturation of induced magnetism could easily be obtained in large masses of iron.

The above sketch is necessarily but the merest outline of the work which has been done, and the discoveries which have been made in the science, for the most part quite recently. It has been my endeavour to bring forward those researches which have resulted in the greatest practical usefulness, or which are best calculated to help us in forming a good conception of the physical cause and nature of magnetism. I will now endeavour to place together some of the leading theories which have been advanced from time to time to answer the question, "What is magnetism?"

Many of our profoundest thinkers have after careful consideration been able to offer no solution of this difficult problem, and it will be generally admitted that although at the present day we may presume to possess a fairly accurate knowledge, as far as it goes, of some of the physical conditions which exist in a magnet, the question is still unanswered. Why, when these physical conditions exist, do we get the effects of magnetism?

A few facts stand out very prominently as requiring satisfactory explanation. One of the most striking is that although there is no absolute distinction between magnetic and non-magnetic bodies, there is a very vast difference between iron, nickel, and cobalt on the one hand, and all other substances on the other.

Among many other phenomena which arrest attention and demand explanation may be mentioned residual magnetism, hysteresis, induction, and the variation of its intensity with many circumstances, etc.

In the days of Sir Isaac Newton very little indeed was nown about magnetism, and we look in vain for any ideas om him. This great philosopher, who stated the laws hich govern the motion of bodies, and many other laws, clearly that they are accepted now just as he enunciated hem, felt incompetent to offer any explanation of magnetic henomena; and Gilbert, with whose name is associated he first we hear of the science, contented himself with a eclaration of the phenomena he observed.

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[*] *Phil. Trans.*, 1885.

[*] *Phil. Trans.*, 1886.

[†] *Proc.* Royal Society, 1889.

Poisson and Coulomb seem to have been the first to ame a theory, and almost all subsequent theorists have greed with them to this extent, that magnetism has a olecular nature.

They assumed that each molecule is a sphere, containing wo distinct magnetic fluids, which are separated under the nfluence of magnetic force, and that a certain inherent oercive force keeps the two fluids from mixing in the case f a permanent magnet. Such a theory explains the nductive action which takes place between magnets and nagnetic bodies, but not much more.

Sir Wm. Thomson was perhaps the first to express is disbelief in these fluids in 1849, and he established mathematical theory founded mostly on Coulomb's esearches.

Weber's theory is an improvement on Poisson's, and his views were good enough to be entertained by Clerk Maxwell with certain modifications. He held that each molecule of iron is a magnet before any application of magnetising force, and that the axes of the molecules are turned in all directions; that the axes were deflected towards parallelism by a magnetising force; and that each one tends to return to its initial position.

This theory would account for saturation and for some of the effects of temperature, but does not explain retentiveness, and is silent about the connection between the magnetic and other properties of iron.

Clerk Maxwell agreed with Weber in his explanation of neutrality, but offered an explanation of retentiveness based on the analogy of magnetism to mechanical strain. To use his own symbols, he supposes that when a molecule is deflected by a magnetising force, X, it returns to its initial position when X is removed, if the angle of deflection, β, of its axis has been less than a certain limit, β_0. If, however, β_0 has been exceeded, it does not completely return, but remains with its axis deflected through an angle $\beta - \beta_0$.

But under these circumstances, as Ewing* pointed out, we should expect, on sudden reapplication and withdrawal of X, to obtain a purely elastic series of changes, so that this modification and extension of Weber's theory does not allow of the existence of hysteresis.

Ampère's theory is at first sight very plausible, and goes a little further than any other theories before or since in stating what the magnetism of a molecule actually consists of. It is based on the analogy of electric currents, and supposes that an electric current flows round each molecule in a closed circuit of no resistance, and that neutrality is due to a miscellaneous, and magnetisation to a symmetrical, arrangement of the molecules.

This theory has this advantage—shared by no other—that it readily accounts for many of the observed connections between magnetism and electricity; but a serious objection is that, as far as we know, electric currents cannot exist without a constant expenditure of energy, and in any case we do not know what an electric current consists of.

De la Rive, in 1853, held Weber's views concerning the inherent magnetism of every molecule, and the cause of neutrality; but he recognised retentiveness, and assigned it to the resistance of the molecules to change their relative positions, calling this resistance "coercitive force."

Wiedemann in his "Galvanismus" gives a molecular theory, which is in some respects the same as that held at the present day. In that work he states, and was probably the first to do so, that neutrality consists of a symmetrical arrangement of the molecules. Hughes lays claim to the first assertion of this condition of neutrality. Into the question of this priority I do not propose to enter further. In any case, Hughes in 1883 formulated a very complete theory of the physical conditions which accompany the states of neutrality and polarity, and since these assumptions, as far as they went, constituted for many years the current creed, I think they are worth stating in full.

"1. That each molecule of a piece of iron, steel, or other magnetic substance, is a separate and independent magnet, having its two poles and distribution of magnetic polarity exactly the same as its total evident magnetism when noticed in a steel bar magnet.

"2. That each molecule or its polarity can be rotated in either direction upon its axis by torsion, stress, or by physical forces, such as magnetism and electricity.

"3. That the inherent polarity or magnetism of each molecule is a constant quantity like gravity, that it can be neither augmented nor destroyed.

"4. That when we have external neutrality, or no apparent magnetism, the molecules, or their polarities, arrange themselves so as to satisfy their mutual attraction by the shortest path, and thus form a complete closed circle of attraction.

5. "That when the magnetism becomes evident, the molecules, or their polarities, have all rotated symmetrically in a given direction, producing a north pole if rotated in one direction as regards the piece of steel, or a south pole if rotated in the opposite direction. Also, that in evident magnetism we have still a symmetrical arrangement, but one whose circles of attraction are not completed except through an external armature joining both poles.

"6. That we have permanent magnetisation when the rigidity, as in tempered steel, retains the molecules in a given direction, and transient magnetism whenever the molecules rotate in comparative freedom, as in soft iron."*

The last clause is not quite correct in the light of Ewing's later experiments on the ratio of residual to induced magnetism, inasmuch as soft iron is undoubtedly more retentive than tempered steel; and clauses 4 and 5 may also require considerable modification, but, nevertheless, much praise is due to Hughes for the manner in which he placed some of the physical accompaniments of magnetisation almost beyond the region of speculation, by his very ingenious and indefatigable applications of the induction balance, and for the way in which, before bringing forward this theory, he submitted the statements in it to experimental demonstration, by a method of investigation which had been impossible before the introduction of the balance.

Ewing's experiments on hysteresis and retentiveness, though they do not form the basis of a new theory, are of great service in exposing the weak points of previous theories, especially those of Weber and Maxwell. When he recorded the results of those experiments† he at the same time stated that to form a mechanical conception of the process of magnetisation, it is necessary to assume an elastic tendency on the part of the molecules to recover their initial position when displaced; a static frictional resistance opposing such displacement; and also a viscous resistance to the displacement—these three assumptions being intended to account for residual magnetism, hysteresis, and time-lag respectively.

But quite recently Ewing's own views have undergone considerable change, in consequence of experiments which he made with a model intended to illustrate the actual movements of the molecules of magnetic bodies, and in a paper describing these experiments, which he read before the Royal Society, June 19, 1890, he says that although the motion of a frictional resistance to displacement of the molecules accounts well for hysteresis, and its reduction by vibration, it opposes the fact that some magnetism is induced even by the feeblest magnetising force. He then proceeds to work out a theory the essence of which is, that it is not necessary to suppose that any forces are constraining the molecules, except those due to their own mutual attractions and repulsions, which are quite sufficient to account for the directional stability of the molecules.

Such a theory accounts well for effects of stress, temperature, vibration, etc., upon magnetic quality. It attributes hysteresis to the transition of a system of molecules from one position of rest to another through an unstable condition. It explains why, even when there is no external manifestation of magnetism, magnetic metals exhibit hysteresis in their general physical properties with relation to stress, etc., and many other phenomena too numerous to discuss fully here.

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* *Phil. Trans.*, 1885.

* *Proc.* Roy. Soc., vol. 34.

† *Phil. Trans.*, 1885.

Hopkinson has always been very guarded in the expression of his own views, and his work has largely consisted in laying a solid foundation experimentally for the building up of subsequent theory. The suggestions which he has made are worthy of every consideration. He ventures, as an explanation of the striking difference between the three magnetic metals and all other bodies, that ordinary temperatures exceed the critical temperatures of these bodies, and that possibly if we could obtain sufficiently low temperatures many other bodies might exhibit polarity. If this be so, another question receives additional weight—viz., Why has temperature such an enormous influence on the magnetic properties of bodies?

A careful analysis of the above theories brings us to the conclusion that we are at present quite ignorant of the essential nature of magnetism. A knowledge of its physical accompaniments is quite indispensable to the formation of a true theory of its constitution, and in this respect we are presumably on the high road to the ultimate solution of the problem. It is just possible that, bearing in mind (1) the close relationship which exists between magnetic and electric phenomena, (2) the effect of magnetism on light and of light on magnetism, (3) the important part which temperature plays in the possibility of the external manifestations of magnetism, any theory which receives final acceptance may be found to introduce electricity, light, and heat as essential to the complete manifestations of magnetism.

In spite of all the advances which have recently been made in magnetism, the science may possibly still be in its infancy, and it well becomes us to review the theories of former years with all humility, and to advance and hold our present notions with all modesty and reserve, not knowing how soon these also may be proved to be inadequate, and therefore appear antiquated.

UNDERGROUND LIGHTING MAINS IN PARIS.*

BY E. DIEUDONNÉ.

(Continued from page 177.)

The sector conceded to the Société d'Eclairage et de Force par l'Electricité is of large extent, special considerations having determined certain points of its perimeter. It extends from the Grand Boulevards to the north part of the Paris Fortifications, comprising the line of the Boulevards de Magenta, Strasbourg, and Bonne Nouvelle, the Place de la Republique, the Rues des Faubourgs Saint-Martin, and Saint-Denis.

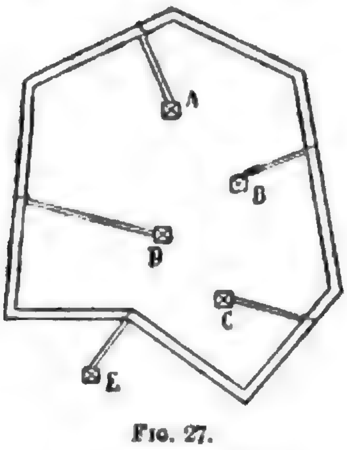

FIG. 27.

This large district is supplied from five central stations situated in the Rue de Bondy, Rue des Filles-Dieu, Quai de la Loire, Faubourg Saint-Denis, and Boulevard Barbès.

The distributing network is composed of two conductors, fed by feeders which maintain an almost constant difference of potential. The system may be represented schematically, as in Fig. 27, in which the letters, A, B, C, D, indicate the central stations connected to the distributing mains by feeders. Only one pair of feeders from each station is shown; in reality, there are a large number. Pilot wires, leading back to the station, reveal the pressure existing at the several points of attachment of feeders to network.

Of the five stations mentioned, two receive power from a central high-tension generating station situated at Saint-Ouen, on the banks of the Seine, these two being the stations of the Boulevard Barbès and the Faubourg Saint-Denis. Continuous-current transformers reduce the high-tension current to a pressure of 124 volts.

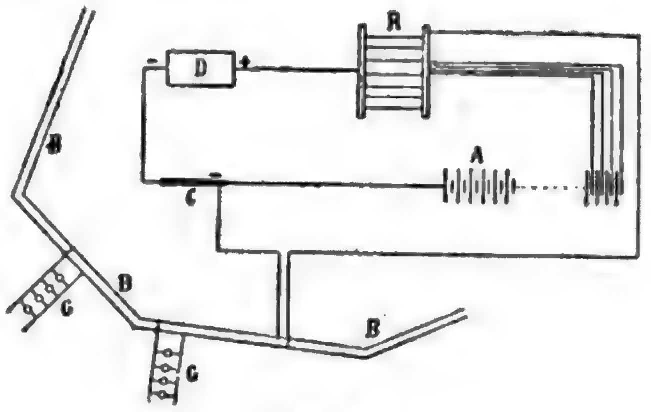

FIG. 28.

The three other stations produce low-tension currents, each having their generating apparatus of boilers, steam engines, and dynamos supplemented with enormous batteries of accumulators charged in parallel with the lamps. Fig. 28 shows the electric arrangement of these stations. The negative pole of the dynamos, the accumulators, and one of the feeders are connected to the negative terminal of the switchboard.

The lines connecting the high-tension station to the two sub-stations in Paris are partly overhead and partly underground. The overhead portion is formed of copper cables, generally bare, carried on wooden posts by means of double-bell porcelain insulators. The underground portion of these is carried out on the same plan as that of the general network we are going to describe.

In general the conductors are formed of bare cables, carried by porcelain insulators, sealed with sulphur, upon galvanised iron stems. The latter are nicked at each end, and their lower extremity is also sealed with sulphur into an iron frame placed in the conduit. Figs. 29 and 30 show these cast-iron plates, with their sockets rimmed interiorly for receiving the insulator supports. Figs. 31 and 32 give the position of the insulators within the conduit shown in section. The first of these shows both distributing mains and feeders, while the second shows only distributing mains.

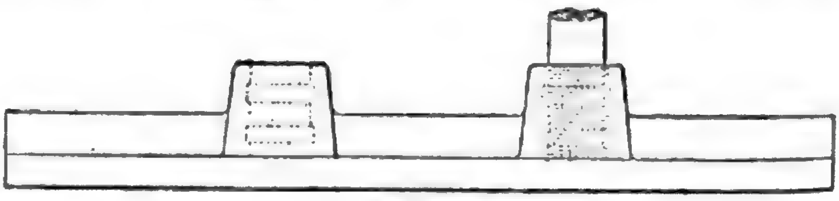

FIG. 29.

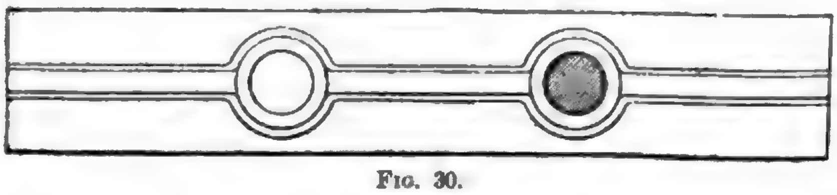

FIG. 30.

The conduit is formed of cement concrete made on the spot, and laid within trenches below the pavement. This method of proceeding enables considerable variation from the straight to be made, and gives the power, often very useful, of being able to run curved conduits, and thus singularly facilitating the laying. The cover of the conduit is formed of flags of moulded cement.

The cables are fastened to the insulators by means of special screw clamps of galvanised iron. The insulators are of the form shown in Figs. 33 to 35. They are furnished at the upper surface with two lateral projections moulded on the body, and ribbed on their lower surface to receive the horizontal bar of the clamp. The cable is firmly fixed, by means of screws, to the head of the insulator. This arrangement is a modification, brought about by the inconveniences experienced in the first type of insulators, Figs. 31 and 32, where the square lug was apt to be broken off by unequal tightening.

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* From *L'Electricien.*

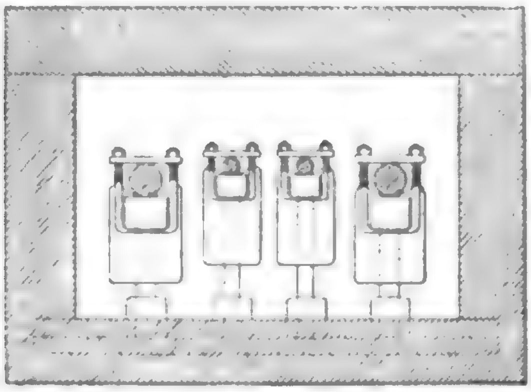

FIG. 31.

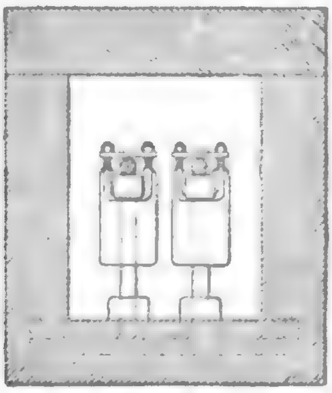

FIG. 32.

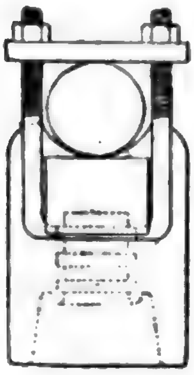

FIG. 33.

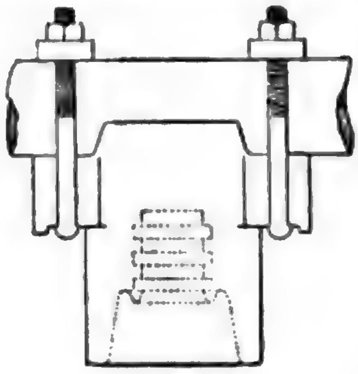

FIG. 34.

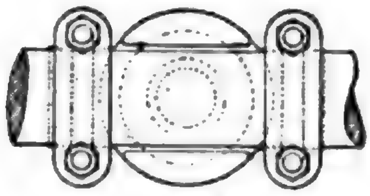

FIG. 35.

(To be continued.)

DRAWING IN CABLES.

The minor improvements in apparatus frequently are of great assistance in saving labour and trouble. We herewith illustrate a piece of apparatus of the kind, which is simple, cheap, effective, and saves a good deal of trouble and money, not to speak of the less frequent misuse of hard language.

When drawing electric cables into pipes, Callender-Webber cases, or other conduits, it is necessary to make a secure connection between the cable and the rope by which it is to be pulled in. It is also necessary that such connections should be small enough to pass through the pipe or case. The method usually adopted at present is to make a splice by cutting out the centre strands of the conductor and "marrying" the outer strands to those of the rope. The grip designed by Mr. Voysey avoids this waste of time and material. It consists of a small ferrule, 2in. or 3in. long, tapered inside, and made so that the narrow end fits closely to the conductor for the cable. The ferrule is placed on the end of the conductor, narrow end foremost, the insulation being cut back 2in. or 3in., according to the length of the ferrule. When in position, a tapered pin is driven into the centre of the cable, and this spreads the strands so as to make the ferrule grip more tightly the more it is pulled.

FIG. 1.

On to the end of the rope is permanently connected a small cap, which is then screwed on to the ferrule. Thus, in two or three minutes, a joint (of smaller diameter than the cable) can be made capable of sustaining any strain required. After the cable is drawn in the ferrule can be easily removed by taking out the tapered pin, which is provided with a small head, so that it can be knocked out without difficulty. It has also great advantage over an ordinary splice, which may "ruck up" when being drawn over sharp bends. The saving of expense and time may be shown by giving the cost of the present method. Let us take a $^{91}/_{11}$ cable, and the cost is as follows:

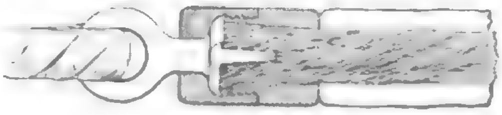

FIG. 2.

	s.	d.
Jointer, 1½ hours making and unmaking splice ...	1	0
10 men one hour awaiting same	5	0
1ft. 6in. cable..	11	6
Rope waste, tape for covering splice, etc...........	0	6
	18	0

The grip has been successfully used in drawing in cables into Callender's casing, and its action is perfect. It has a great advantage over the ordinary splice when drawing round sharp bends. It has been estimated that the cost of preparation for drawing in a $^{91}/_{11}$ cable is about 18s., or if the men hauling can be elsewhere employed, and have not to wait on the jointer, at 13s., the greater part of this being due to destruction of cable. With the patent grip a joint is made in a couple of minutes or so, instead of in as many hours, and the waste of cable is exceedingly small. The grip is made of bar steel, so as to have it as strong as possible. The accompanying figures explain themselves. Fig. 1 shows the grip as fastened to the cable. Fig. 2, a section when so fast; and Fig. 3, the various parts in position.

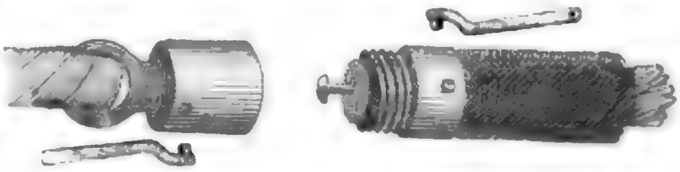

FIG. 3.

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THE EUROPEAN SIMS-EDISON TORPEDO COMPANY.

It is vulgar, and no doubt libellous, to write of any company promoted that it is a swindle, known and intended to be a swindle ; yet if the truth could be written, that is just the description of a large percentage of the companies floated at the present day. We are unable to characterise the newly-promoted Sims-Edison Company by any such vulgar title—not that we should hesitate to do so, libel or no libel, if we had the necessary information to judge this particular case. There are only two ways of knowing the exact status of a company: (1) by being behind the scenes from the start, (2) waiting for the lapse of time to prove that which is good. There is, however, a third means by which those who are not wilfully blind may see a little and imagine more. The blurred outline, and the utmost stretch of the imagination, however, fall far short of certainty. So it is in discussing the probable history of the Sims-Edison Torpedo Company. The real information at our command or at the command of any investor, is so meagre that from it alone no person ought to have subscribed a single halfpenny. Those who have applied for shares, have "gone it blind." They may have drawn a winner, though the probability points rather to a blank.

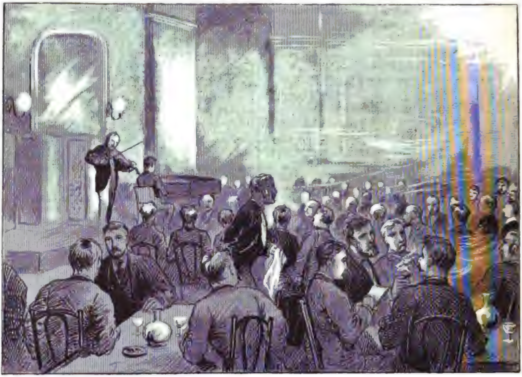
To particularise—this company has been launched by financiers who know their business. They have simply to get the capital, and the promoters take from the capital the prearranged plunder. To get the capital good names are necessary—that is, names of men unconnected with previous great failures, and in whom the public may be expected to have some confidence. A certain part of the payment to vendors goes into the pockets of men who underwrite the capital. In this case the names are put forward, and £150,000 somehow or other goes to the vendors. Now £150,000 out of £201,000, the capital of the company, is a large slice, but it leaves £51,000 working capital. In other words, the prospectus states distinctly that about £50,000 is a sufficient capital for the company ; yet it is watered to about four times that amount—or for every £1 the company gets, £3 is paid away. What does it get for this £150,000 ? A series of patents, benefits of application for patents, patterns, moulds, designs, etc. We will produce designs, moulds, patterns, and patents as good as these have yet proved to be, *ad lib.*, and should like to see £150,000 for each set. But there is worse behind. There are 1,000 founders' shares, and the vendors, of course, have got these, as they are permitted to do ; and should the company earn over 10 per cent. the owners of the founders' shares take one-half the surplus. Once more, what is the company to get for £150,000 ? The patents, designs, etc., of a torpedo *controlled* by electricity. Now, there are five hundred men in this country any one of whom will, for a sum of £500, design as efficient an electric control as that of the Sims-Edison—will design a piece of apparatus that shall carry an explosive as heavy as that in the Sims-Edison torpedo ; that can be lowered or raised out of the water; that can be moved through the water, and its course directed as easily and as effectively as can the Sims-Edison torpedo. There is no patent in designing a watertight chamber, for example, with valves electrically controlled—that can be filled or emptied of water by electrically-controlled apparatus. The Sims-Edison mechanism is, no doubt, pretty; but that it is worth £150,000 is placing an altogether imaginative value upon it. Divide that amount by 30, and you have the outside value. A quotation from the *Times* is given in the prospectus, in which the advantages of the application of the Sims-Edison design to lifeboats is extolled. No one with an extended knowledge of the subject could have written the article containing the paragraph, and only one revelling in the depths of absolute ignorance can believe what it says. "The boat they have designed [not built or tried] could be sent through the surf for miles up and down the coast if necessary," etc. No, sir; no boat ever built or ever designed could be manœuvred miles up and down the coast through the surf during a heavy storm by any electrical devices at present known, the boat being controlled through wires connected with a stationary dynamo on shore. If the company imagines that it will obtain an income from the construction of lifeboats it is woefully mistaken. David's example will be followed, and we shall continue to use the boats whose qualities and capabilities are known by long trials, and not put these away for untried concerns even to please patentees and promoters. Again, the English Government probably knows more of the capabilities of electrically-controlled torpedoes than the whole world outside, and it will be difficult to convince them that Sims-Edison has produced a better weapon of offence and defence than they already have in the Whitehead and the Brennan. We notice that mention of the latter torpedo is carefully left out of the prospectus. A closer examination of the words of the prospectus will show how indefinite is its language, and how easily it will be to say in the future this or that was not promised. In fact, all is surmise—thus "is believed to be"; "among the advantages claimed"; "every important port presents a field"; "the extent of the demand can readily be understood"; "on terms the directors believe to be"; "have expressed their willingness"; "a trial has been arranged to take place"; "should this company sell," and so on. A paragraph in the prospectus, evidently intended to incite investors, is to the effect that the United States Government has adopted this torpedo. That may be so, but such adoption is no benefit to the "*European* Sims-Edison Company," for they certainly will not supply the American market. Patents have been obtained in England, France, Belgium, Austria, Luxembourg, and Italy. Of course the company has the right to future applications for patents in Europe, India, Burmah, and British Colonies. Has application been made in Germany, and if so, has it been refused? What is the estimated value of the Luxembourg patent? Is it added to make a more imposing list? What about Russia, Greece, Holland, Denmark, Norway and Sweden, Turkey, and Spain? These countries are given as employing torpedo-boats, but not as having ratified the invention by patents. Altogether the prospectus is the most badly worded of any we have ever seen, and the whole concern seems a huge joke to see how far the public will have confidence in a sounding title and a set of taking names, rather than a keen desire to establish a paying business. Investors, remember that you pay away £3 for every £1 usefully employed by the company, and the founders' shares take the cake when there is any.

THE PROFESSION.

Mr. Cuthbert Hall in an article given elsewhere discusses from one point of view the entrance into the profession of electrical engineering. We are not quite sure that these views accord with the majority. As salaries go, £300 a year is not to be despised, nor is it usually thought that a college-trained man is better than one who has worked his way up through the shops. We shall not, however, attempt to discuss the whole question, but only to refer to one point that is too frequently overlooked by young men. They seem to imagine that if a local authority advertises for an official to fill a newly-created post in electrical engineering matters, that official is to expect the salary of a prime minister or the manager of a London gas works. Local authorities know that in most instances the work attached to the new department will for some time to come be comparatively light, and that it will grow as years pass on, and light and power gradually develop. We are under the impression, then, that to expect large salaries is a vain expectation, and that interested parties had better make up their minds to accept a small salary and hope for its increase with the growth of their work. Gas managers have to contemplate the gradual working their way to the important and better paid posts, and electrical engineers will have to follow the example thus set them.

ELECTRICAL ENGINEERS AT PLAY.

The end of the summer, or the beginning of autumn, sees the commencement of the meeting season which holds sway during the long, dark evenings. Many of these meetings are intended to provide mental pabulum; others, and probably the better appreciated, provide for social intercourse. The meetings of the Electro-Harmonic are of the latter kind. They form an excuse for members of the profession to release their business manner and to meet each other as "hail fellow well met." Music, vocal and instrumental, is the great attraction. The first meeting of the session was held on Friday evening last, when our artist was smuggled in as an electrical engineer, and has



Electrical Engineers at Play.

in the accompanying picture endeavoured to delineate the scene. The moment he has chosen is one when Mr. Gatehouse is producing sweet sounds from that king of instruments, the violin. The next concert of the society is on November 6.

LAUFFEN SWITCHBOARDS.

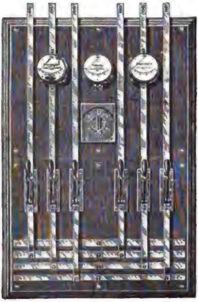


Fig. 1.—Low-Tension Switchboard.

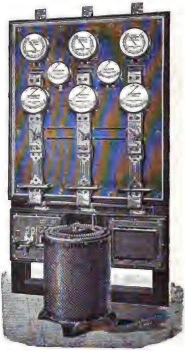


Fig. 2.—Switchboard at Lauffen.

The accompanying illustrations of the switchboards, Figs. 1 and 2, used in the Lauffen-Frankfort transmission experiments explain themselves, while Fig. 3 is another view of the transformer as described in our issue of September 25th. The current is generated at 60-70 volts at Lauffen and passed through fuses and low-tension switches to the transformer. There are no switches in the high-tension circuit; but the current passes through high-tension fuses of three sets of two copper wires in parallel, each ·15 millimetre diameter (about No. 34 gauge), 6ft. 6in. in length, stretched between the first two poles. The whole of the 300 h.p. passes through these six thin wires. At every railway station along the line is a stout length of copper wire of V-shape inverted, hung over the three wires, which can be dropped, and so blow the fuses should necessity arise.

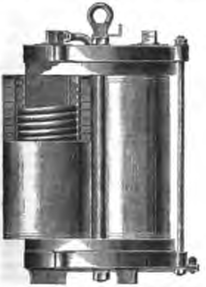


FIG. 3.—Lauffen Transformer. Sectional Elevation.

THE PROFESSION OF ELECTRICAL ENGINEERING.

BY H. CUTHBERT HALL.

If a young man, or youth leaving school, wishing to become an electrical engineer, seeks advice as to what course he shall pursue in order to achieve the desired end, he is usually told that one of three courses is open to him, either of which is calculated to provide him in a greater or less degree with the equipment which he needs.

If he is pecuniarily well off, he may go to a university and study mathematics and, perhaps, the theory of electricity, and then proceed, on leaving the university, to attach himself to a firm of electrical engineers as an articled pupil, there gaining that practical knowledge of his profession which his university training will enable him to receive to the greatest advantage. Or he can, without any special theoretical training, join a firm immediately on leaving school and endeavour to acquire such theoretical knowledge as is attainable after his day's work in the factory is done The third alternative which is open to him is to join one of the numerous technical colleges which profess to combine theoretical with practical training, and to turn out efficient engineers after a one year's, two years', or three years' course.

Of these three courses the former is undoubtedly the best, as by following it a man is enabled to acquire both theoretical and practical training under the most favourable conditions. The second course probably comes next in order of merit, but the theoretical training is necessarily placed at a great disadvantage by the fact that it has to be pursued when the student is wearied with physical labour. The third course is perhaps the least advantageous of the three, as in the endeavour to simultaneously acquire practical and theoretical knowledge the student not infrequently fails in satisfactorily acquiring either the one or the other.

Whichever course, however, is ultimately decided upon and pursued, involves the expenditure of a good deal of time and money, and the person in question not unreasonably looks forward to receiving, at the end of his apprenticeship, a return in some measure proportioned to the trouble and expense which he has incurred. But in this respect he is, in nine cases out of ten, most grievously disappointed; for some of the best firms of electrical engineers are not ashamed to offer men of exceptional education, ability, and training, salaries which would be regarded as poor by the average City clerk.

To the uninitiated it would seem incredible that in order to properly qualify for the position of electrical engineer it should be necessary to spend several years in preparation without receiving any pecuniary advantage, and to have to go to the expense of paying a premium and college fees, and that at the end of the term of preparation a salary should be offered very little higher than would be paid to a raw youth, fresh from school, on entering a commercial house. As an instance of what frequently occurs, the career, based on actual facts, of an electrical engineer may be cited, and may, perhaps, prove not uninteresting. It is briefly summed up as follows: Preliminary education at a public school; proceeded to Cambridge; came out in the mathematical tripos a fifth wrangler; spent three years as an articled pupil at a well-known firm of electrical engineers; became, on expiration of term of articled pupilage, a member of their staff, at a salary of £100 per annum. Cost of three years at Cambridge, about £800; premium to firm of engineers, £300; salary received after six years' training, £100 per annum.

Now here is the case of a man of considerable ability, as proved by the degree which he took, laying out over £1,200 in preparation, and after six years receiving a salary of only £100 per annum. And this is no exaggerated case, but quite as good, if not better, than is the fate of nine out of every ten.

In reply, it may be urged that the profession offers many prizes, which really first-class men obtain; but this is not the case, for positions in England worth over £500 per annum are decidedly exceptional.

A short time ago an important town in the West of England advertised for an electrical engineer to take charge of the central lighting station there, and in order to obtain so important a position a man would certainly have had to have been able to claim a considerable experience of this class of work, nor would it have been of much use for a very young man to offer himself for the post; yet for this important position the paltry salary of £300 per annum was offered. A director of several large electric lighting schemes recently admitted in conversation that he was surprised to find for what low salaries really efficient men could be obtained, and the enumeration of instances might be multiplied of men holding important positions in connection with electric lighting schemes and firms of electrical engineers, at a remuneration which would be considered insufficient for a responsible man engaged in a branch of commerce which required no technical training or education above that afforded by the Board schools.

In the case of electric lighting schemes some slight excuse may be offered for the payment of such low salaries, because in so many instances no dividend has been earned, but where a firm of electrical engineers and contractors is in question it is notorious that large fortunes have been made of late years, and similar excuses cannot therefore be offered by them for the underpaying of their employés which so frequently exists.

The reasons for the exceptionally bad position of electrical engineers, as compared even with other classes of employés, are several in number, and, perhaps, even a cursory inspection of them may suggest at any rate a partial cure.

The profession has undoubtedly many advantages. The immunity which it offers from the drudgery of the desk is a great attraction to many, and the fact that applied electricity, as a science, is comparatively in its infancy, induces many to join the ranks of electrical engineering who would feel little interest in more beaten tracks. But in one sense this very attractiveness is a bane of the engineer, for many men are, at any rate, partially reconciled to receiving insufficient salaries because of their fondness for the work. But the primary cause of the low salaries which are paid is undoubtedly to be found in the fact that no test is imposed by any responsible body on those who wish to enter the profession. In fact, anyone can call himself an "electrician," from the local ironmonger upwards. The consequence is that the profession is crowded with a number of incapables, whom a very elementary examination would probably be the means of weeding out. Of course these men do not often obtain responsible positions, but the fact of the supply, although of an inferior quality, being so large, seriously detriments those who are really competent to hold positions of trust.

Ignorance and inexperience in an electrical engineer are productive of results quite as disastrous as would be the display of similar qualities in many professions which are now privileged. To be a really first-class electrical engineer demands much patient work and more than average ability, and it is quite time that some duly accredited body took in hand the task of putting the profession of electrical engineering on a footing better befitting its dignity and importance.

SOME DETAILS OF THE CARE AND MANAGEMENT OF AN ARC LIGHTING SYSTEM AS PRACTISED IN THE MUNICIPAL OF ST. LOUIS.*

BY JAMES I. AYER.

As central station men, it seems to me that we should demand of each other as much knowledge of the practice and experience as it is practicable to give. In fact, if this association is to be useful, our meetings should be largely "experience meetings," and the practical experience of those engaged in the development of the lighting and kindred industries, if given liberally at each meeting, would be followed closely by those interested in the production of electrical apparatus and supplies, and would do much to advance the business and improve appliances. Believing that we are here, as central station managers, for mutual improvement and for the free interchange of ideas and experience, I have presumed to present you with a limited, though doubtless dry, outline of the practice which obtains in the central station under the writer's charge.

The station, as designed, has a working capacity of 6,000 arc lights, and is now operating daily 3,500, and about 200 constant-current motors. Two thousand of these lights are distributed over an area of 60 square miles, suspended between and from poles 50ft. and 65ft. in length, at a height of from 35ft. to 50ft. above the roadway, an average distance apart of about 900ft., and used for street lighting. The motors and about 1,500 lamps are operated for the usual varied service of private consumers. Sixty-nine circuits supply the lamps and motors, containing about 1,200 miles of wire and supported on 12,000 poles.

For generating the current, we have six 600-h.p. Corliss engines, which drive 300ft. of shafting, from which are driven 65 60-light, and 12 80-light 2,000-c.p. arc dynamos. The arrangement of the dynamos is such that we have ample room for the care of 85 machines on a floor space of about 100ft. by 45ft., and are able to operate a large number of dynamos with a very limited amount of help. Four boys, and one young man of very limited experience, care for all the machines during the night, in an entirely satisfactory manner; while a suitable man, with three assistants, give the necessary care to the dynamos during the day.

Thirty-one trimmers, with horses and carts, travel about 500 miles a day to renew the carbons in the street lamps. The average number of lamps to each of these trimmers is 68. Sixteen trimmers care for the 1,500 commercial lamps. Five inspectors, or troublemen, with carts and horses, care for the lines night and day, answer fire-alarms, locate faults and correct minor troubles on the lines. Two day and two night inspectors care for the commercial arc and 2,500 incandescent lamps. A stable of 20 horses, in addition to the 40 horses owned by the trimmers and inspectors, is required. The maintenance of 60 vehicles justifies a blacksmith and waggon shop, which, with the stable, require the service of eight men. Two men care for the shafting and three engineers and four oilers for the engine-room. In the boiler-house, where there are 19 300-h.p. boilers, there are two pump men, with two assistants, 12 stokers, one boiler cleaner, and six coal shovelers. These, together with an average force of 35 line and ground men, foremen, chief trimmer, chief inspector, superintendent of lines, storekeeper, repair shop employés, carpenters, clerks, etc., constitute a force of about 170 men. A very large percentage of these men are called upon to perform duties which are simple, yet, because of their extreme newness, are not thoroughly comprehended by them. To get the best results, each man requires clearly written rules, as few of them as possible and their rigid enforcement. In all practice this is the wise way to put it; but it is absolutely necessary that it be so with a large force, where many of the men do their work independently and free from the constant supervision of a foreman.

In the room used as an office at the station by the inspectors and foremen are city maps, mounted on boards, where the locations of the lamps are indicated by tacks and the circuits by strings. For the central part of the city, where there are many circuits on the same line of poles, each circuit is shown on a separate map of that section. A number of printed slips, which represent a pole with cross-arms, indicate the location of the wires on the poles on the different streets traversed by the different circuits. Any change of circuits is noted on a separate blank when the work is ordered, and when completed the maps are corrected to correspond. It takes but a few days for a man to become quite familiar with the circuits, by keeping them so conspicuously placed. In large stations this method of indicating circuits is almost indispensable, and will prove of great value if used in smaller ones.

For testing purposes we have a portable tachometer for indicating speeds, two Thomson indicators for the engines, a recording steam gauge, two standard ammeters and a voltmeter reading to 5,000 volts for the dynamo-room; on each circuit a spring socket for attaching ammeters and a current indicator for indicating the direction the current is flowing through the circuit; near the lightning arresters on the upper floor, a switchboard specially arranged for testing only; a Wheatstone bridge, magneto bells, etc. The engines are indicated once each day.

Evaporation boiler tests are made every month to see that the quality of coal is maintained at the standard. All the circuits are tested four times each day. All live circuits during the day are tested for grounds, and all others for apparent open circuits as well. In addition to this, all circuits are tested while alive by taking volt and ammeter readings simultaneously. The number of miles of wire and number of lamps being known, any material increase in the energy consumed gives evidence of a fault not always easily discovered by other methods. In testing for grounds on circuits not alive a strong magneto bell is used. For all other testing a battery current of from 30 to 50 volts is used, and the circuit is required to pass at least one ampere to operate an ordinary call bell. When this bell is placed in series with a circuit which has more resistance than will pass this current at the pressure, the circuit is at once inspected and the fault located. In locating the trouble, one side of the bell circuit is connected to the line and the other to earth. The inspector or troubleman carries a similar bell with him, which he connects in series with the earth and line at various points, until the fault is located. The value of circuit testing with low voltage is keenly appreciated by those who have practised it. When the circuits are alive, ammeter readings are recorded every two hours, and all readings are from the same instruments. These instruments are arranged so as to be read singly or in series, and one is used to check on the other.

The stopping and starting of engines and boilers, pumps, dynamos, circuits, etc., are all recorded on reports made by those in charge of the different departments. Each inspector, trimmer, line foreman, storekeeper, and all heads of departments make daily reports of work done, and time and material used by them. Each trimmer is charged with a certain number of demerits for each fault on his route, such as defective or dirty lamps, broken or dirty globes, carbons used in excess of the required number, etc, and each month prizes are awarded to those having the best records.

The advantage of using vehicles for trimmers for all street-lighting work is being recognised. Provide a man with proper appliances and your service will improve. He cannot carry all that he should and walk long distances, nor will he take the same care when he is worn out with tramping that he otherwise would. We find it desirable for the trimmer to own and care for his own horse, while the company provides a suitable vehicle and harness, which he turns into the stable once a week for inspection, cleaning, and repairs, when needed.

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* Paper read before the Convention of the National Electric Light Association.

We select from our linemen those whom we class as inspectors or troublemen, who are equipped with a light-running cart, with a suitable place for the storage of all tools necessary to use in an emergency. In addition to the special duty required of them during storms or at fires, these men correct all minor troubles reported to the office from various sources. During the first year's operations the average time lost, due to open circuits at night—that is, the average time lost from the time the circuit was opened until it was closed and the lights restored—was an hour and five minutes, notwithstanding that all circuits are more than 10 miles in length. When these troubles occur, it is almost always during a storm; but the conveyances with which they are provided, and their thorough knowledge of the circuits, enable them to become very expert in locating and correcting troubles. During the past year nearly 15 per cent of all the calls answered by our troublemen were to correct troubles on the lines of other companies. Because we have wires all over the city, the police, and the public generally, think that all the wires belong to us, and, when they discover any trouble with them, are very apt to report the same by telephone to our station. During the entire 24 hours there is always one man on duty, ready to answer just such calls and correct the troubles.

All arc lamps, before leaving the station, are placed in a test rack, where they are supplied with a current maintained absolutely constant. Voltmeter readings are noted soon after the lamps have been lighted, when the carbons are about half consumed, and also when they are burned quite short. During the early part of the burning the lamp is adjusted so that the readings, taken at three different points, give an average reading of 46 volts. In case of double lamps, this work is carried out on both rods. This extreme care in regard to adjustment we regard as absolutely necessary. If a lamp is permitted to consume its carbons, any fault which would not be discovered by a brief test is quite likely to develop. To determine the length of arc by the current and voltage is more likely to result in uniform lamps than were tested by the eye. With 10 lamps, adjusted to burn at an average of 46 volts, with 9·5-10 amperes, the average number of watts per lamp was 436. Without changing the adjustment of the lamps, the current was increased to 9·8-10 amperes, and there was an average consumption of 524 watts per lamp, an increase of 20 per cent. of energy, and by increasing the current to 10 amperes the average number of watts per lamp was 550, the average voltage 58, the increase above normal being 33 per cent. That means 33 per cent. more coal, 33 per cent. more work at your dynamo, 31 per cent. less capacity in your dynamo, and probably 33 per cent. less life in your armature. One is apt to think that the difference between 8·5-10 and 10 amperes, when supplied to the lamp, is only a difference of 5 or 10 per cent., which is not very serious. This would be true if the lamp were adjusted each time for the ampere current it was to be operated with. To those who have not made this experiment, perhaps, a portion of the mystery as to where the coal goes will be cleared up. By using the ammeter and voltmeter for adjusting the lamps, and then seeing that the circuits are provided with the same ampere current indicated by the same ammeter, one will be apt to bring about like conditions in all lamps; at least, they are more likely to be uniform than if independent ammeters are used on each circuit. By reference to this statement relative to the amount of energy consumed by change of current, it will be easy to see how expensive one or two low lamps would be on a circuit where the operator, to correct the trouble, supplies them with current enough to make them bright. Of course it is understood that better service as well is obtained by operating the circuits with no more current than that for which the lamps are adjusted. In this connection, I believe it is proper to again call attention to the well-worn subject of connections. A great deal of time and trouble is spent in soldering joints, and when the lines are led to the lamp they are apt to be poked into the binding posts, held with set screws indifferently tightened, and between these binding posts and the lamp connections proper there are perhaps three or four, if not more, indifferent contacts, all of which look very well in the factory, but are very bad after a few months' service. Hanger-boards should be used which have the line wire soldered to connections which cannot get loose. In our practice we accomplish this by using about 18in. of flexible insulated cable, which is soldered to the hanger-board binding posts at the station (cut-out boxes are treated in the same manner), leaving the lineman nothing but an ordinary line joint to make, which can be easily done outside. Where lamps are suspended from the hanger-boards by the hooks which conduct the current, we always insist on some character of second connection being made to the lamp besides this. A simple way to do this is to take some small wire and tie the hook to the loop, in much the same manner as you would with a piece of twine. We have no screw connections anywhere in our circuits, and with a little ingenuity and care they can be avoided always in arc lighting circuits. By the use of a special socket in each circuit for connecting an ammeter, we are able to take the readings with volt and ammeter, and get a correct indication of the actual consumption of energy on a circuit while in operation. With data relative to the number of lamps in service, and the number of miles and size of wire, we are able to discover any excessive consumption of energy and prevent the development of a series of little faults, which in a short time grow to be very serious ones if permitted to continue. Usually these readings are taken on each circuit three times a week, and during the time these observations are made indicator cards are taken from the engines. From these two sources we get the actual consumption of electrical energy per circuit and per engine. We also get the indicated horse-power. From a set of 11 observations, taken from July 30 to August 28, at various hours during the night run, the station shows an efficiency, between indicated horse-power and electrical horse-power, at dynamo terminals of 74·9 per cent., ranging from 70·3 per cent., the lowest, to 77·5 per cent., the highest efficiency shown. The circuit readings indicate an average consumption of energy per lamp of about six-tenths of an electrical horse-power. The average indicated horse-power is about eight-tenths per lamp. A good condition of the circuits is maintained constantly, because any neglect in any department is quickly shown by the data obtained from our records. Some months ago, when press of business caused the measurement of circuits to be neglected for a few weeks, the writer discovered an increase of over 10 per cent. in the consumption of fuel, when there should have been a slight decrease. An investigation showed that an accident to an ammeter had caused a false reading, which increased the cost of fuel alone about 16dols. a day. The difference in the appearance of the lamps was not such as to call forth special comments then by those interested, yet when the fault was discovered, it was remembered that some seemed to have been burning high for a week or two. On suburban circuits on long loops it is our practice to place cut-out boxes on the pole where the line branches. This saves a great deal of time in locating troubles, but let me add that unless a throroughly water-tight and substantial cut-out is used, it will prove more of an annoyance than an advantage. A log of each circuit and dynamo, as well as of engines and boilers, is a very satisfactory and desirable part of the records, and will frequently assist materially in locating troubles and saving expense.

Throughout the country it is almost the universal practice to wire for arc lights without cost to the customer. There is no valid reason for this custom, and for more than a year it has been our custom to charge for cost of labour, with the result of reducing expenses more than 600dols. per month. In every case where lamps are discontinued in the spring, we require a contract for fall and winter service, else the wires are removed when the lamp is taken down. We invariably cut down the line between the house and pole where the service is discontinued for the season, though it is to be renewed later. To induce annual contracts, a rebate of 5 per cent. is given at the expiration of the year, and is found to work to advantage.

(To be continued.)

THE KEYS' COMPANY'S GALVANOMETER.

The galvanometer of the Allgemeine Elektricitäts Gesellschaft, of Berlin, for whom Keys' Electric Company are the representatives for this country and the colonies, has the advantages of great reliability, and the readiness with which the records can be read off without entailing the necessity for any intricate calculations.

The accompanying illustration shows the compact and convenient form of the instrument, which is suitable equally for the determination of insulation resistances, for testing joints, and for laboratory and workshop use, as well as for installation work, central station use, and ordinary line testing. Resistances of 500 to 1,000,000 ohms can be measured with an exactness quite sufficient for most practical purposes.

These instruments consist of an exceeding sensitive galvanometer, connected with a dry battery of the most approved form, in the manner explained by the annexed cut, Fig. 2, where T B represents the battery, G the galvanometer, having an outer coil of 1,500 turns of fine wire and an inner coil of 150 turns of stouter wire; *a* one terminal, and b_1 and b_2 (as may be required) the other, to which the outside resistance to be measured must be attached. This latter is thus connected with the battery and galvanometer in series, so that the deflection of the needle gives a direct determination of the outer resistance, which, owing to its having been standardised before leaving the works, can be read off without further calculation or trouble upon the calibration tables to be seen close to the scale.

A spindle, with finely-pointed ends set in agate, carries at one end and within the coils a strong magnet, and above them a light pointer which plays over a finely-divided scale. The large number of turns of fine copper wire, wound in sections, leading to the binding screw, b_1 (or b_2) permits the selection of the number of turns employed to be so as to correspond with the amount of resistance.

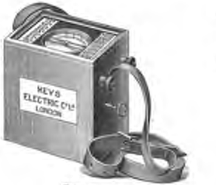


FIG. 1.

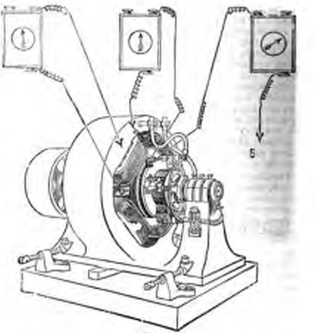


FIG. 4.

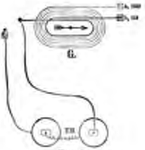


FIG. 2.

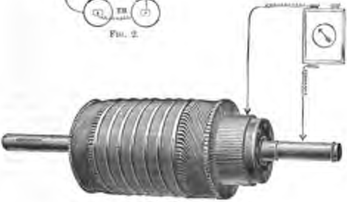


FIG. 3.

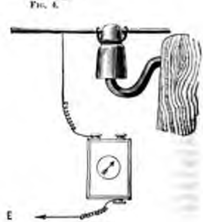


FIG. 5.

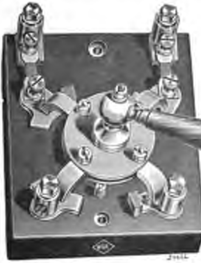
The dry battery is of high E.M.F. and great constancy. The instrument case is well nickelled, and the whole secured in a neat polished wooden box furnished with straps, so as to be conveniently portable, and very compact.

The other illustrations, Figs. 3, 4, and 5, show a few of the many ways in which it may be employed: I. Insulation tests between commutator and spindle. II. Insulation tests between magnet coils and iron parts in dynamos, etc. III. Insulation tests between field magnets and armature. IV. Insulation tests between armature and earth. V. Circuit-testing for earth or bad joint.

Two sizes are made—one for resistances up to 500,000, the other up to 1,000,000 ohms.

DOUBLE-POLE SWITCHES.

The practice of placing switches in both paths of an electric lighting circuit, especially at the entrance to buildings which are supplied with electric current from central station supply mains, has much to recommend it. When switches are so arranged, the current may be shut off from all contact with the house wires, except while the lamps are actually burning; and so the risk of leakage be lessened and the possibility of damage to the insulation caused by the constant strain on the dielectric be minimised.



Messrs. Woodhouse and Rawson have lately introduced types of double-pole switches which combine, on one base and with one movement, the action of two separate ordinary switches. Our illustration shows the form given to those intended for ordinary pressures. It is "quick-break," the handle is fitted loosely, and powerful springs come into play and break both circuits simultaneously. Care is taken to insulate the two circuits completely from one another, and to maintain the high-class character of their switches.

ARTIFICIAL RAINMAKING.*

BY PROF. EDWIN J. HOUSTON.

Whenever a large mass of air is cooled below the temperature of its dew point, the moisture it can no longer hold as invisible vapour becomes visible. If the reduction of temperature be but slight, the vapour appears as fog, mist, or cloud; if the reduction be considerable, as rain or snow.

There has been no little attention given lately to the question as to whether or not rain can be caused to fall at pleasure on any given section of the earth—rain machines, or artificial rain producers, consisting essentially of devices whereby explosions of nitro-glycerine, or other similar substances, are obtained at fairly considerably elevations in mid-air, have been tried in different forms. As to the success of these attempts at the artificial production of rain, the testimony appears to be uncertain or contradictory.

The idea of rainmaking by mid-air explosions is probably based on the rains that are generally believed to attend or follow great battles, Fourth of July celebrations of the Chinese character, and volcanic eruptions. Passing by the evidences produced by either the warlike or the peaceful burning of gunpowder, which at best are but vague, it may be remarked that volcanic eruptions may produce very heavy rainfalls, not only because the force of the eruption and the intense heat cause upward currents in the air, but also because of the vast quantities of vapour of water that escape from most volcanoes during their eruptions.

There is a fascination in witnessing man's struggle with the forces of nature—a struggle, be it understood, not made to oppose such forces, but rather to direct them. The former effort would be foolish; the latter must meet with success, if properly directed.

Do the scientific facts, as far as known to meteorology, give any encouragement for the continuance of the efforts of the would-be rainmakers? Let us enquire.

It is now generally agreed that the lowering of temperature necessary for the production of rain may be obtained in the following ways:

1. By the intermingling of masses of warm and cold air.
2. By the carrying of warm moist air into a cold place.

In any case the cause of the rain is, briefly, the cooling of the air until it is unable to retain all the moisture it formerly held as invisible vapour, and deposits the excess in a visible form as rain.

The quantity of the rainfall will, therefore, depend both on the amount of moisture present in the air, and on the extent of reduction of temperature produced.

The first method—viz., the lowering of temperature by the intermingling of masses of warm and cold air—can never produce any very considerable rainfall, since, though the warm air is cooled by its mixture with cold air—and the tendency is, therefore, to cause the mixed air to become relatively moister—yet at the same time the cold air is made warmer, and, therefore, relatively drier. Drizzling rains might be produced in this manner, but scarcely ever heavy rainfalls, unless both the cold and the warm air contain large quantities of moisture.

There remains, therefore, but the second way of lowering the temperature of the air—viz., by the carrying of the warm air into a colder place. This can be accomplished in three different ways:

1. By a change of latitude, or by a warm moist air blowing into a colder latitude. In general, the equatorial currents blowing toward the poles are the chief rain producers.
2. By a change in altitude, effected by an ascending current due to a heated area. Here the lowering of the temperature is due not only to the cold of elevation, but also to that produced by the expansion of the air under lower pressure
3. By a change in altitude, due to a mountain range opposing the progress of a wind, and thereby necessitating its gradually creeping up the sides of the mountain.

In any of these ways heavy rains may be produced and, in point of fact, they are probably the only ways in which heavy rains are generally produced.

Applying the preceding principles to the case of the modern rain machine, let us enquire as to the probabilities of its successful operation. The simultaneous, or the successive explosion of large quantities of any high explosive, in the upper regions of the atmosphere, must produce, in general, a rapid and more or less thorough mixing or stirring of the surrounding air.

The sudden expansion of the air, both by the heat liberated by the explosion and by the gases evolved during the explosion, is attended by a rush outward, followed by a rush of air inwards, towards the explosion centre. The direction of this latter rush is generally radially inward. In addition to these inward motions, the heat generated may tend to produce a slight upward motion; the general effect must be, however, to produce a mixing or churning rather than an upward motion.

The immediate effect of the explosion is to produce a miniature area of low barometer, caused by the radial rush of air towards the explosion centre, and by whatever ascending current that may result from the liberation of heat.

It would be reasonable to suppose that if the explosion produces any direct effect on atmospheric conditions, the area of low barometer should follow immediately, or nearly so, after the explosion. Have such changes in the barometric pressure been noticed to follow such mid-air explosions?

So far as the mixing motion is concerned, its action to produce a fall of rain must be slight. The ascending motion might cause a rainfall, but as this motion is slight in extent, its action under ordinary conditions must at best be but insignificant.

In either case, any decrease in temperature, and consequent increase in relative humidity, must necessarily be slightly decreased by the dry and heated gases evolved during the explosion of such substances as nitro-glycerine, dynamite, or gunpowder.

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* Paper read before the Electrical Section of the Franklin Institute, Sept. 8th, 1891.

It might be supposed from the above considerations that balloons containing an explosive mixture of hydrogen and oxygen would be preferable to those carrying nitro-glycerine, dynamite, or gunpowder, since, in the former case, the vapour of water results from the explosion, and in the latter dry gases. It must be remembered, however, that the explosion of mixed oxygen and hydrogen produces, for the greater part, a collapse, or radial rush inwards towards the explosion centre, while the explosion of gunpowder or nitro-glycerine produces, for the greater part, a radial rush from such centre.

A circumstance that appears to have been lost sight of in all the recent attempts at rainmaking, is that such attempts have been apparently made regardless of the hygrometric conditions of the air. As rain is but the excess of moisture, which the warm moist air, when sufficiently cooled, is unable to retain, the amount of the fall will depend, as already stated, on the quantity of moisture in the air as well as on the extent of the chilling action following the explosion or other cause. To attempt to produce rain by explosions in mid-air, irrespective of the quantity of moisture in the air, is to attempt to cause water to fall from the air when practically none is present. This is not only illogical but absurd.

It may be thought by some that the concussions caused by mid-air explosions might result in such a general movement of the surrounding air as to cause rain to fall over an extended area. The flash of the explosion is followed by a sudden movement of the air causing the noise of the explosion. The phenomena of lightning and thunder are somewhat similar to those of artificial mid-air explosions. First we have the lightning flash, and subsequently the thunder, which is a violent concussion of air. Does this concussion bring down a heavier rainfall? Popularly it is believed to do so, but the general opinion of the scientific world is that the lightning flash is the effect of a rapid condensation of the aqueous vapour—*i.e.*, of a heavy rainfall—and not the cause of such a fall. That is to say, the high potency of the lightning flash is due to the enormous decrease in the surfaces of the already charged rain drops over that of the surfaces of the thousands of the separate drops that coalesce to form the single drops.

Nevertheless, the liberation of heat energy and the rapid admixture of air following the disruptive discharge may slightly increase the rainfall, or may act as a determining cause of rain over an extended area.

There is this difference between the lightning flash and the flash of an explosion—viz.: The former occurs over a comparatively great length of path—*i.e.*, a space of small breadth and depth but great length. The latter occurs in a comparatively limited space, the three dimensions of which are nearly equal.

Though lightning is not a cause of rain, there can be no doubt that if rain can be artificially produced during a period in which there is much free electricity in the air, the storm will be attended by lightning and thunder. If, then, there be any increase of rain due to the presence of lightning, artificial rainmaking will be more liable to succeed when the potential of the air, as regards the earth or neighbouring clouds, is comparatively high.

The enormous expenditure of energy required to produce a rain storm over an extended area is a circumstance that would appear to give but little encouragement to man's many efforts in this direction. The amount of energy librated by the greatest explosion man has yet effected in mid-air, is but insignificant when compared to the energy liberated by nature during even a comparatively limited fall of rain.

There is, however, an important consideration bearing on the question of the probable success of rainmaking by mid-air explosions that gives to such attempts a far greater probability of success than would appear to be warranted from the facts already enumerated. Presupposing the existence of a sufficient mass of moist air, at preferably a comparatively high difference of potential as compared with the neighbouring air or the earth, a mid-air explosion might act as the determining cause of rainfall over a wide area, the balance of the energy requisite therefor being supplied by the moist air. In a mass of very moist air there exists a store of energy which, if liberated, would suffice to cause movements of the air of vast extent. When the vapour of the air is condensed, the potential energy becomes kinetic, and, being liberated by the heat, causes ascending currents which produce a further condensation of moisture, and further liberation of energy previously locked up in the vapour.

There sometimes exist conditions in the air in which it is, so to speak, in a state of very unstable equilibrium, and a slight determining cause may result in the liberation of the stored-up energy with a resulting heavy rainfall. In such cases it would appear that there are no reasons why an explosion in mid-air should not be followed by rain. At the same time it is not unreasonable to suppose that the natural causes which brought about such conditions would, in many cases, continue to act, and thus cause rain without artificial aid.

There are, however, meteorological conditions that probably frequently exist in certain latitudes in which heavy rains might be artificially produced by mid-air disturbances, when, without such disturbances, no rainfall would occur. Should, for example, a layer of warm moist air exist between the earth's surface and a higher layer of cold moist air, separated by a comparatively thin layer of air, and should such conditions exist as to maintain the two layers separate, then the breaking or piercing of the intermediate separating layer might permit such an up-rush of the warmer air through the opening, that the liberation of its stored-up energy through the condensation of its moisture, would result in a general up-rush of the warm moist air and the consequent production of an extended area of low barometer. In other words, the artificial rupture of the separating layer would result in the formation of a true storm centre and a heavy rainfall of considerable dimensions. In such cases it would appear:

1. That mid-air explosions will be more effective than explosions on the earth's surface.

2. That directed mid-air explosions—*i.e.*, explosions in which the general effect of the liberated energy is to produce an upward rush of air—would be more effective than undirected, haphazard explosions.

If in such cases considerable difference of potential exist between the layers of air, or between that of the air generally and the earth, the lightning flashes would unquestionably be effective in piercing the separating layer, especially if, as would probably be the case, the general direction of the discharge be between the layers of cold and warm air.

Since, as we have seen, it is the ascending current that causes the heaviest rainfall, it would appear that mid-air explosions of such a character as to produce in general an upward rush of air would be probably more successful than undirected, haphazard explosions in mid-air. Such movements might advantageously be effected by the liberation of rockets with enlarged conical heads, or of any form of firework that would move generally upward.

Since success in artificial rainmaking is probably dependent on the meteorological conditions, both of the lower and upper layers of the atmosphere, efforts should be made to enlarge our present very limited knowledge of such conditions.

Captive balloons, containing registering electrometers, tele-thermometers, tele-hygrometers, tele-anemometers, etc., might be connected by wires with recording apparatus placed on the earth's surface. The cost of maintaining such aerial stations of observation would be but insignificant when compared with the benefit that would accrue not only toward the solution of the problem as to the probable success in rainmaking, but also in the aid given to the general operations of the United States Weather Bureau in particular, and to meteorology in geneal.

During the general prevalence of moist warm air, when but a slight cooling is necessary to cause a general downpour, effective rainmaking might be obtained by the sudden breaking or opening of cylinders of liquefied gases, where expansion would cause an intense chilling of the surrounding air; such cylinders could be readily opened by means of earth-controlled electromagnets.

The following general conclusions may, in view of the present state of meteorological science, be properly drawn concerning the artificial production of rain.

1. That rain can never be made to fall at will by mid-air explosions on any part of the earth's surface, irrespective of the climatic conditions there existing.

2. That during certain meterological conditions, mid-air explosions may result in rainfall over extended areas.

3. That the liberation of energy necessary for such rainfalls is due not to the mid-air explosions, but to the energy stored up in the moist air from which the rain is derived.

4. That the meteorological conditions which must exist for the successful action of mid-air explosions would probably in most, though not in all cases, themselves result in a natural production of rain.

5. That a comparatively high difference of electric potential between different parts of the air, or between the air and the earth, is possibly favourable when taken in connection with other meteorological conditions for artificial rainmaking.

6. That an undirected mid-air explosion is not as likely to produce rain as an explosion in which the main tendency of the energy liberated is to cause a general up-rush of the air.

BRIDLINGTON.

The following gives the particulars of the electric lighting at Bridlington. The Local Board purchased plant for lighting the Princes Parade by arc lamps, consisting of a Thomson-Houston H^{12} dynamo, capable of running 18 1,200-c.p. lamps. Of the lamps, 10 (Thomson-Rice K type) are placed on ornamental cast-iron columns, 16ft. high, supplied by W. Macfarlane and Co. The dynamo is driven by power supplied by Thornham and Co., of the Victoria Sawmill, situated about a quarter of a mile from the parade. The wires are run overhead from the mill to the parade. At the entrance of the parade they are brought down in Dan Ryland's glass-lined iron pipes, and carried underground in 4in. Archer patent pipes to the lamps. The Laing, Wharton, and Down Construction Syndicate fixed the plant and ran it for 12 weeks, and then handed it over entirely to the Local Board, whose surveyor, Mr. R. Railston Brown, has the entire charge and management of the plant. The light is not used all the year, but only during the season, and it has given general satisfaction. The mill engine runs at 90 revolutions per minute. Countershafting and belts transmit the necessary power to the dynamo, which runs at 950 revolutions per minute. Each 1,200-c.p. lamp absorbs about ½ h.p. The lamps are in series, and as each lamp takes 6·8 amperes at 50 volts, the 10 lamps take 6·8 amperes at 500 volts. The station is supplied with the usual testing instruments. During the time of construction, and up to the time the contractors delivered over the works, Mr. H. C. Buchanan was in charge, but, as above stated, Mr. Brown has now the entire responsibility.

HALIFAX.

The following is the report of the Electric Construction Corporation to the chairman and members of the Halifax Lighting Committee:

Dear Sirs,—In accordance with your instructions, I now have the pleasure of submitting report on electric lighting.

Site for Central Station.—The old Salvation Army Barracks are well situated for this purpose. The area, of approximately 660 square yards which they cover, will allow of a plant being installed capable of supplying 10,000 16-c.p. running lamps, which is the sized plant I understand you propose to install, and throughout this report all figures are based on this assumption. With a view to future extension it would be well if more land could be obtained adjoining the present site.

System of Distribution.—A low-tension continuous-current system should be adopted, with distributing mains arranged on the three-wire system, current being supplied to these mains by feeders run from the central station to various points on the network. An E.M.F. of 105 volts would be the most convenient one to adopt, as this allows of arc lamps being supplied from the same mains as the incandescent lamps; the current would also be available for running motors.

Generating Plant.—As you requested, the relative merits of "steam *versus* gas," for the supply of the motive power, have been carefully considered and estimates prepared for both systems. The cost comes out practically the same in each case, so that I have only thought it necessary to give you detailed particulars of the steam plant, as this is the one I should recommend for adoption.

Gas engines have several features which place them at a considerable disadvantage as compared with steam. In the first place, it is doubtful whether the manufacture of gas at the central station would not be a nuisance to the neighbourhood, and in event of plant being installed at your present gas works this would necessitate a main of about 18in. diameter being provided to convey the gas to the central station. At present the gas engines are only made of comparatively small power, so that a large number of units would have to be used. Heavy and expensive flywheels would have to be fitted to the dynamos to overcome the unsteady running of the engines. They do not run well under a continually varying load, and are much more noisy than steam engines, and likely to cause trouble from adjoining property owners or occupiers on this account. Some further particulars of the comparative cost of the two systems are given under the head of "Cost of Running."

In a properly designed steam plant, the boilers fired by mechanical stokers, and a good quality of coal used, there would be no nuisance from smoke. However, as gas engines are now making very rapid strides, there may be some developments in the course of the next 12 months that will place them in a more favourable position than at present, and as at least this time will elapse before the provisional order is obtained and you are in a position to proceed with the work of installing plant, this point might then be again reviewed.

Mains.—These would be entirely underground, and consist either of bare copper strips, run upon insulators carried in iron, brick, or concrete troughs, or insulated cables drawn into iron pipes or into holes in an insulating casing similar to the Callender-Webber system. The mains are most conveniently run under the footpaths. The Corporation should undertake the excavation and making good of the roads.

Cost of Running.—For the purpose of estimating the running expenses I have assumed that you would sell 600,000 units per annum. This is equivalent to 20,000 16-c.p. lamps being connected on to the mains, and each run on an average 500 hours per annum, which I think is a fair estimate. This you will be able to check by comparison with your gas lighting plant. Estimates have been prepared with both steam and gas as the motive power, though I only now submit the one for the steam plant. It will be noticed that the actual expenses of fuel, water, oil, etc., and engine-room labour, are only a small proportion of the total costs, and though the gas engines are slightly more economical in the consumption of fuel, the extra labour necessary for attending the larger number of units more than compensates for this saving. The maintenance charges should be debited each year, and any balance there may be after doing what repairs are necessary to keep the plant in a thoroughly efficient state, should go to a renewal fund.

Meters.—There are now several reliable forms of meters in the market. One should be fixed on each consumer's premises, and remain the property of the Corporation, the customer paying such a rental as will cover the interest on the capital outlay and the cost of maintenance.

Wiring Buildings.—The cost of putting up the necessary cables, wires, switches, etc., for lighting premises is often the reason why electric lighting is not more readily adopted; so that with a view to encourage the sale of current, it may be well for the committee to consider the advisability of the Corporation undertaking this work, and, subject to proper agreement being made with the consumer, charging a rental upon the cost of installation or on a deferred payment system, spreading the cost over, say, three or five years.

The average cost of installation in mills, workshops, offices, shops, and private houses would be from 16s. to 18s. per 16-c.p. lamp, including everything necessary, excepting the lamp itself and any brackets, electroliers, or such fittings.

Central Station Now Running.—When in Halifax I visited this station. The plant would not be of any use for the station now proposed, though no doubt it has done good work in introducing the electric light into the town, and in the event of the Corporation taking over the business they would have a certain demand for current from the very commencement of their supply.

I place myself at your service to supply any further information, and should be pleased to come over and meet the committee, if you think this desirable.—Yours faithfully (for the Electric Construction Corporation, Limited),

J. H. WOODWARD.

ESTIMATE OF RUNNING EXPENSES CALCULATED UPON A SALE OF 600,000 UNITS PER ANNUM.

Engine-room Expenses.				£	s.	d.
1,860 tons of coal at 10s.				930	0	0
Water at 6d. per 1,000 gallons				84	0	0
Oil, waste, packing, and sundry stores				200	0	0
Four stokers, 28s.	£191	4	0			
Five engine drivers, 35s.	455	0	0			
Three greasers, 26s.	202	16	0			
One switchboard man, 40s.	104	0	0			
				953	0	0
Maintenance.						
Boilers, engines, dynamos, and whole of generating plant, 5 per cent. on £21,425				1,071	5	0
Building, 2½ per cent. on £3,500 + £2,000 (estimated value of present building)				137	10	0
Mains, 2½ per cent. on £20,000				500	0	0
General Charges.						
Chief engineer's salary				300	0	0
Ground rent, insurance, meter examiners, collection of accounts, and general office expenses				1,200	0	0
Interest at 4 per cent. per annum on capital outlay of £53,313				2,132	10	0
Or a cost of 3d. per unit.				£7,508	5	0

With a sale of 400,000 units per annum, the cost, after making the necessary allowances for decrease in fuel, consumption, etc., comes out at 4·26d. per unit.

ESTIMATED OUTLAY FOR PLANT TO SUPPLY 10,000 RUNNING LIGHTS OF 16 C.P. EACH.

Generating Station.	£	s.	d.	£	s.	d.
Five Babcock-Wilcox 160-h.p. boilers, each evaporating 5,000lb. of water per hour; erected complete with all necessary brickwork	3,365	0	0			
Five mechanical stokers	720	0	0			
Four 250-i.h.p. compound engines, fixed complete	7,000	0	0			
Two 80-i.h.p. compound engines, fixed	1,150	0	0			
Feed-water heaters, pumps, steam, feed and exhaust pipes, valves, etc.	2,030	0	0			
Four dynamos of 150 kilowatts each, fixed	3,200	0	0			
Two dynamos of 50 kilowatts each, fixed	800	0	0			
Six sets cotton driving ropes	100	0	0			
Switchboards, instruments, cables, and connections inside the buildings, fixed	1,000	0	0			
Cables, wires, switches, lamps, etc., fixed complete for lighting the station	60	0	0			
Spare plant and sundries	2,000	0	0			
				21,425	0	0
Buildings.						
Including alteration to present buildings, chimney, main flue, main exhaust pipe, foundations for boilers, engines, and dynamo, feed-water storage tank, travelling cranes, water service and main drain, say				3,500	0	0
Mains.						
For 10,000 actual running lights of 16 c.p. each, including feeders and distributing mains over an area extending to half a mile radius as a maximum all round the central station				20,000	0	0
Meters.						
500 current meters, at £8 each				4,000	0	0
General Charges.						
Engineer's commission, law charges, etc., 7½ per cent.				3,669	0	0
				£52,594	0	0

MAURITIUS PAST AND PRESENT.

THE NECESSITY OF TELEGRAPHIC COMMUNICATION WITH ZANZIBAR.

At the weekly meeting of the Balloon Society of Great Britain, held at St. James's Hall, W., on Friday evening, October 2nd, a paper was read by Mr. H. Bonnefin, M.R.C.S. (England), L.R.C.P. (London), on the above subject, Mr. W. H. Le Fevre, C.E., in the chair. After giving a historical and geographical description of the island, the lecturer stated that Mauritius is at the present day the only important colony of the British Empire deprived of the advantages of telegraphic communication with the other countries. The nearest telegraph stations are Natal and Zanzibar. Efforts have from time to time been made to establish a cable connection with these points. In 1873 the colony entered into a contract to this effect with Hooper's Company, which was never carried out. The sum of 100,000 rupees per annum was voted by the colony, but this amount did not suffice. A proposal was submitted by the Telegraph Construction and Maintenance Company in conjunction with the Eastern Telegraph Company, comprising a connection with Mauritius, but the Imperial Government, whilst giving a subsidy for the Aden and Natal cable, declined to give any assistance whatever to establishing communication with Mauritius. Last year, by the aid of the Imperial Government, the cable was laid from Halifax to Bermuda, thus placing the authorities at home in direct communication with that most important dockyard and naval station. The Post Office have now invited tenders for the construction of a line to Mauritius from the east coast of Africa direct to the Seychelles, and thence direct to Mauritius. This will of course necessitate a slight deviation from the direct route to Mauritius, but the addition to the length of the cable is more than justified by the consideration that it will result in placing the outlying dependency of the Seychelles in direct communication with the Government at Port Louis, nearly 1,000 miles away. No specific subsidy is offered, the amount being left to the parties tendering. It is hoped that no difficulty will arise upon this point, as the Mauritius Legislature have practically agreed to give a subsidy of £7,000 a year, and it is anticipated the Seychelles dependency will vote a grant of £1,000 a year. Any failure to come to terms would greatly be deplored, for the Imperial importance of the proposed cable is beyond question. The strategic position occupied by Mauritius is one of immense value. It stands in mid-ocean at a point 2,000 miles distant from Aden, 2,340 miles from Cape Town, and 2,040 miles from Ceylon, and in the event of hostilities might command the commerce of the Indian Ocean. It is obvious enough, then, for military purposes alone, taking into account the rapid development of our Australasian Colonies and Indian Empire, that it is no longer desirable to leave so important a station dependent upon the postal service, as at present is the case. It may have, too, from a commercial point of view, the effect of developing a greater interest here at home in a delightful colony. I therefore trust that the present Government will deal with this question fairly, and that in the event of the contract requiring a vote from Parliament, the House of Commons will sanction the completion of the links of that electric chain which will bind the mother country with one of the oldest and most loyal colonial possessions.

The following resolution, proposed by Mr. J. Ernest (Mauritius), seconded by Mr. S. A. Jackson (Hong-Kong), was adopted:

"That the proposed cable from Zanzibar to Mauritius, *via* the Seychelles, is of Imperial importance in a strategical point of view, and will also have the effect of developing the trade between the mother country and one of the oldest possessions of the British Empire."

LONDON COUNTY COUNCIL.

The following is the report of the electrical business before the London County Council at the last meeting:

Notices under Electric Lighting Orders and Acts.

We have to report that we have, acting upon the authority conferred upon us to deal with matters during the recess, sanctioned the works referred to in the undermentioned notices:

28th July, 1891, from the Metropolitan Electric Supply Company, of intention to lay mains in Suffolk-street, Pall-mall East, Cockspur-street, and Trafalgar-square, west side.

August 13th, 1891, from the Notting Hill Electric Lighting Company, of intention to lay mains in Holland Park; and 15th August, 1891, from the same company, of intention to lay mains in Pembridge place and crescent.

The works proposed were of very small extent, and it was intimated to the companies concerned that, subject to the usual conditions, they might be proceeded with. We recommend:

> That the Council do ratify the action taken by us with reference to these notices.

We have also considered a notice from the Notting Hill Electric Lighting Company without date, but received at this office on 29th August, 1891, of intention to lay mains in Pembridge gardens and square. There appears to be no objection to the proposed works; and we recommend:

> That the sanction of the Council be given to the works referred to in the notice (registered No. 233), without date,

> of the Notting Hill Electric Lighting Company, upon condition that the company do give two days' notice to the Council's chief engineer before commencing the work; that the cover-stones of the culverts under 20in. wide shall be not less than 2in. thick, and of the wider culverts not less than 2½in.; and that where the culvert crosses the carriageway, there shall be at least 9in. thickness of Portland cement concrete above the cover-stones of the culvert, in addition to the road material.

We have considered two notices from the Westminster Electric Supply Corporation, one dated 25th August, 1891, of intention to lay mains in Sussex-street, Cumberland-street, and Westmoreland-street, and the other, dated 9th September, 1891, of intention to lay mains on the west side of Regent-street, from Conduit-street to St. George's Church. The proposed works are unobjectionable, and we recommend:

> That the consent of the Council be given to the works referred to in the notices, dated 25th August and 9th September, 1891, respectively, of the Westminster Electric Supply Corporation, upon condition that the company do give two days' notice to the Council's chief engineer before commencing the works; that the mains be laid under the footways wherever it is found practicable to do so; and that the covers of the street boxes to be used shall consist of iron frames filled in with material to suit the paving.

The House-to-House Electric Light Supply Company has served a notice, dated 1st September, 1891, of intention to lay a main across Earl's Court-road at Earl's Court-gardens. There seems to be no objection to this proposal, and we recommend:

> That the sanction of the Council be given to the works referred to in the notice, dated 1st September, 1891, of the House-to-House Electric Light Supply Company, upon condition that the company do give two days' notice to the Council's chief engineer before commencing the work; that no pipes of a larger diameter than 6in. shall be used; that the street boxes to be used shall be of the pattern approved by the Council; and that as an additional precaution against accident through defective insulation of the mains, each of the street boxes shall be provided with an inner as well as an outer cover, each insulated from the other as far as practicable, and that the outer cover shall be efficiently connected with earth.

A notice, without date, was received on the 2nd of September, 1891, from the Kensington and Knightsbridge Electric Lighting Company, of proposed extension of mains in Brompton-road, from Montpelier-street to Fulham Bridge-road. These works are of the ordinary character; and we recommend:

> That the sanction of the Council be given to the works referred to in the notice, without date, of the Kensington and Knightsbridge Electric Lighting Company.

The London Electric Supply Corporation has given a notice, dated 5th September, 1891, of intention to lay two lines of distributing mains, consisting of concentric lead-covered cables in iron pipes, in Tooley-street and Montague-close, Southwark. There appears to be no objection to what is proposed, and we recommend:

> That the sanction of the Council be given to the works referred to in the notice, dated September 5th, 1891, of the London Electric Supply Corporation upon condition that the company do give two days' notice to the Council's chief engineer before commencing the works; that the mains be laid under the footways, and be kept 9in. below the under side of the paving wherever it is found practicable to do so; that where the mains cross the carriageways they be kept at the same depth below the concrete or the road material as the case may be; that all pipes or openings from or into the boxes shall be of such shape as to remove all risk of injury to the covering of the cables; that all cables crossing the boxes shall be supported from below in the boxes; that all service lines or small cables shall be protected where leaving the boxes by an extra lead covering, or by wooden stoppers, and shall also have a copper wire of sufficient size carried from the service to the main cable in good connection with the lead or iron outer casing; and that the ends of all mains terminating elsewhere than in a box shall be securely protected by iron caps in addition to any other covering.

We have considered two notices, dated September 1st and 11th, 1891, respectively, from the St. James and Pall Mall Electric Lighting Company of intention to lay mains (1) across Regent-street, to complete the scheme of mains approved by the Council, and (2) to connect two mains in Regent-street already authorised. The works referred to are of the usual character, and there appears to be no objection to them. We recommend:

> That the sanction of the Council be given to the works referred to in the two notices, dated September 1st and September 11th, 1891, respectively, of the St. James and Pall Mall Electric Lighting Company, upon condition that the company do give two days' notice to the Council's chief engineer before commencing the works, and that the works in Regent-street shall, when commenced, be carried on continuously by day and night until completed.

A notice, dated September 23rd, 1891, has been given by Mr. H. Robinson, on behalf of the Vestry of St. Pancras, under the St. Pancras (Middlesex) Electric Lighting Order, 1883, of intention to lay mains in Park-street, Camden Town, Gordon street and square, Woburn-square, Tavistock-square, Endsleigh-street, and Upper Woburn-place. The proposed works are similar to those previously approved by the Council in the application of the Vestry, and seeing no objection to them, we recommend:

> That the Council do approve the works referred to in the notice of the Vestry of St. Pancras, dated September 23rd, 1891, under the provisions of the St. Pancras (Middlesex) Electric Lighting Order, 1883.

We have considered a notice dated September 24th, 1891, from the Metropolitan Electric Supply Company, of intention to lay mains in Kildare-terrace, Talbot-road, Westbourne Park-passage, Orchard-street, Alfred-road, Bradley place and street, Harrow-road (part of), and Amberley-road (part of). The proposed works are of the same description as those of this company previously sanctioned by the Council, and there seems to be no objection to them. Part, however, of the route to be traversed by these mains consists of narrow alleys, and the company should be required to provide that a thoroughfare shall be kept there while the works are in progress. We recommend:

> That the sanction of the Council be given to the works referred to in the notice dated 24th September, 1891, of the Metropolitan Electric Supply Company, upon condition that the company do give two days' notice to the Council's chief engineer before commencing the works; that provision be made for the works to be carried out in the narrow ways included in the notice without stoppage of the traffic; that the mains be enclosed in iron pipes or efficient casing, and be laid under the footways wherever it is found practicable to do so; that as an additional precaution against accident through defective insulation of the mains, each of the street boxes shall be provided with an inner as well as an outer cover, the two insulated from each other as far as practicable, and that the outer cover, which shall consist of an iron frame filled in with material to suit the paving, shall be efficiently connected to earth.

We have also to report the receipt of the following notices given in accordance with the resolution of the Council to accept four days' (instead of one month's) notice in respect of the laying of service lines from mains already laid:

From the St. James and Pall Mall Electric Lighting Company: July 30th, to 8, Pall-mall, and 50, Glasshouse-street; August 21st, to 7, New Burlington-street, 174, Piccadilly, 163 and 230, Regent-street; August 26th, to 77, Jermyn-street, 10, Sackville-street, and 10, St. James's-square; September 1st, to 182, 218, and 232, Regent-street; September 8th, to St. James's Palace, and to 167, 133, 230, and 232, Regent-street; September 11th, to 90, 198, and 206, Regent-street.

From the Electricity Supply Corporation: 31st July, to the St. Martin's Vestry Hall, Charing Cross-road; 29th August, to 4 and 6, Charing Cross-road; 21st September, to 29, Spring-gardens.

From the Westminster Electric Supply Corporation: 28th July, to 11, Halkin-street West, and to 13, Half Moon-street; to 1, St. George's-road (no date).

From the London Electric Supply Corporation: 24th July, to 146, Borough High-street, and to 77, Southwark-street; 25th July, to 121A, Regent-street, and 41 and 42, Parliament-street; 29th July, to 235, Westminster Bridge-road, and to Garrick-chambers; 31st July, to 143, 413, and 487, Oxford-street; 18th August, to Hibernia-chambers; 20th August, to 43, Upper Brook-street, and 47, New Bond-street; 21st August, to 2, Tooley-street, and to 62, South Audley-street; 28th August, to 233, Borough High-street; 2nd September, to 24, Haymarket; 25th September, to 23, Haymarket, and to 1, Rupert-street.

Electric Testing Station—Meter Inspector.

We have to report, for the information of the Council, that Mr. W. Arnot, who was appointed in February, 1890, at a salary of £200 a year, to act as an inspector under the Electric Lighting Orders and Acts, has resigned his appointment, he having been appointed electrical engineer to the Glasgow Corporation. We have made temporary arrangements for the discharge of the duties, and propose at a future time to advise as to the manner in which the vacancy shall be filled.

NEW COMPANIES REGISTERED.

Atlas Carbon Manufacturing Company, Limited.—Registered by Slaughter and May, 21, Great Winchester-street, E.C., with a capital of £2,000 in £1 shares. Object: to manufacture and deal in electric conductors and non-conductors, machinery, plant, apparatus, instruments, fittings, etc., used in connection with the generation and distribution of electricity, and, with a view thereto, to adopt an agreement expressed to be made between W. J. Woodward of the one part and the Company of the other part. Registered without articles.

Law's Electrical Appliances Company, Limited.—Registered by Davidson and Morriss, 40 and 42, Queen Victoria-street, London, E.C., with a capital of £4,000 in £5 shares. Object: to carry into effect an agreement expressed to be made between Edward Fitzgerald Law of the first part, C. T. D. Crews, Sinclair Macleay, J. T. F. Otway, W. H. James, and E. F. Law of the second part, and this Company of the third part: and also to adopt and carry into effect another agreement expressed to be made between William Clowes and Sons, Limited, of the one part and this Company of the other part; and generally to carry on business as type-setters and compositors (by machinery or otherwise), printers, lithographers, telegraphists, newsagents, advertising agents, stationers, publishers, etc. There shall not be less than three nor more than six directors. The first shall be Major E. F. Law, S. Macleay, J. T. F. Otway, and S. H. Isles. Qualification not specified. Remuneration to be determined by the Company in general meeting.

CITY NOTES.

Great Northern Telegraph Company.—The receipts for September were £24,000.

Brazilian Submarine Telegraph Company.—The receipts for the past week were £5,226.

West Coast of America Telegraph Company.—The receipts for the month of September amounted to £3,650.

West India and Panama Telegraph Company.—The receipts for the half-month ended September 30 were £1,598, against £2,438.

Cuba Submarine Telegraph Company.—The receipts for September were £3,000, against £2,997 in the corresponding period of last year.

City and South London Railway.—The receipts for the week ending October 4 were £748, against £708 for the week ending September 27.

Eastern Telegraph Company.—The traffic receipts for September were £56,589, as against £55,346 for the same period of 1890, an increase of £1,243.

Direct Spanish Telegraph Company.—For the month of September the receipts show a decrease of £522, as compared with the corresponding period of last year.

Western and Brazilian Telegraph Company.—The receipts for last week, after deducting 17 per cent. payable to the London Platino-Brazilian Company, were £4,100.

Eastern Extension Telegraph Company.—The receipts for September amounted to £40,586, as against £43,938 in the corresponding period, showing a decrease of £3,352.

The International Okonite Company notifies that the first annual general meeting has been postponed from to-day (Friday) to Wednesday, the 14th inst., at the Cannon-street Hotel.

City of London Electric Lighting Company.—Colonel Ben Hay Martindale, C.B., has been elected a director of this Company. Application has been made to the Stock Exchange to grant a quotation to the ordinary shares.

The Submarine Cables Trust announces that on and after the 15th inst. the balance of the coupon due in April last—viz., £2—will be paid by Messrs. Glyn, Mills, Currie, and Co., of Lombard-street, between the hours of 10 a.m. and 2 p.m. The coupons should be left with the bankers for examination four clear days before payment.

Brazilian Submarine Telegraph Company.—The accounts of the Company show a profit sufficient to enable the Directors to recommend a final dividend of 1s. per share, making, with previous distributions, a total dividend of 6 per cent. for the year ended June 30, 1891, and also the payment of a bonus of 4s. per share, both free of income tax, which together will amount to £32,500, leaving a balance of £88,210. 16s. 9d., of which amount £60,000 has been placed to the reserve fund, increasing that fund to £474,878. 7s., and £28,210. 16s. 9d. carried forward. The secretary states that the very exceptional increase in revenue mainly arises from the disturbed state of affairs in South America. The register of transfers will be closed from the 12th to the 21st inst., both days inclusive.

PROVISIONAL PATENTS, 1891.

SEPTEMBER 28.

16388. **An arc lamp.** William Stafford Hays, New Bridge-street, Manchester. (Complete specification.)

16407. **Improvements in printing telegraphs.** Herbert John Allison, 52, Chancery-lane, London. (Major Dane Porter, United States.)

16408. **Improvements in electric arc lamps.** Henry Robert Low and The Art Workshops, Limited, 27, Martin's-lane, Cannon-street, London.

16420. **Improvements in telephone transmitters and receivers.** Cecil Burman Callow, Tring Park, Tring, Herts.

16431. **Improvements in means and apparatus for telegraphic purposes.** Albert Mitchell, 38, Chancery-lane, London.

16451. **Improved system of electric train signalling for preventing railway collisions.** William Phillips Thompson, 6, Lord-street, Liverpool. (Eugenio Espiau and Pédro Forrer, Spain.) (Complete specification.)

SEPTEMBER 29.

16456. **Improvements in electric switch apparatus or means for controlling electric circuits.** Alfred George Brookes, 55, Chancery-lane, London. (John P. Cushing, United States.) (Complete specification.)

16522. **Improvements in or relating to electrically soldering or brazing metal.** William Phillips Thompson, 6, Lord-street, Liverpool. (Charles Lewis Coffin, United States.) (Complete specification.)

16487. **Obtaining a fluid for primary batteries and of recovering the effective matter from the spent fluid.** Henry Harington Leigh, 22, Southampton-buildings, London. (Joseph Brown Gardiner, United States.) (Complete specification.)

16526. **Improvements in pencils or electrodes for electric arc lamps.** Henry Harris Lake, 45, Southampton-buildings, London. (Edmund Tweedy, United States.) (Complete specification.)

16530. **Improvements in and relating to receiving instruments or relays for submarine cable and other electric circuits.** Henry Harris Lake, 45, Southampton-buildings, London. (Charles Goodwin Burke, United States.) (Complete specification.)

16549 **Fuse for electric circuits.** Frank C. Helm, 3, Broad-street-buildings, Liverpool-street, London.

16551. **Improvements in and relating to transmitting instruments for submarine cable and other electric circuits.** Henry Harris Lake, 45, Southampton-buildings, London. (Charles Goodwin Burke, United States.) (Complete specification.)

16572. **Improvements in armatures for dynamo-electric machines and motors** William Brooks Sayers, 46, Lincoln's-inn-fields, London.

SEPTEMBER 30.

16612. **An improved form of voltmeter.** Francis Henry Nalder, Herbert Nalder, Charles William Scott Crawley, and Alfred Soames, 16, Red Lion-street, Clerkenwell, London.

16641. **An improved coupling for lightning conductors.** Joseph Lewis, 53, Chancery-lane, London.

OCTOBER 1.

16657. **Improvements in gas outlet valves or plugs for electric battery cells or other like vessels.** William Moscrop, 47, Lincoln's-inn-fields, London.

16680. **An improved electrical switch.** William Hamilton Blakeney, 33, Bath-street, Glasgow.

OCTOBER 2.

16752 **An improved electrical and mechanical alarm clock.** Daniel James Mullarky, 27, Westgate, Bradford, Yorkshire.

16767. **Improvements in apparatus for electric cooking and heating.** Friedrich Wilhelm Schindler Jenny, 1, Quality-court, London. (Complete specification.)

OCTOBER 3.

16866 **A new or improved method of and means for the electrical propulsion of missiles.** Alfred George Melhuish, 208, Choumert-road, Peckham.

SPECIFICATIONS PUBLISHED.

1888.

11503*. **Electric generators.** Pyke and Barnett. (Amended.) 8d.

1890.

14196. **Incandescent electric lamps.** Lake. (Tibbits.) 8d.

16110. **Distributing electricity.** Parker and others. 8d.

16613. **Incandescent lamps.** Möhrle. 8d.

17108. **Dynamo-electric machines.** Pitt. (Thury.) 8d.

17940. **Arc lamps.** Siemens Bros. and Co. (Siemens and Halske.) 8d.

18088. **Telephonic switchboards.** Kingsbury. (The Western Electric Company.) 1s. 1d.

18969. **Measuring resistance, etc., of electric conductors.** Price and Gray. 6d.

20321. **Lighting tables, etc., by electricity.** Stovell. 8d.

1891.

7949. **Secondary batteries.** Goward. 8d.

11134. **Electrolysis of chloride of aluminium.** Faure. 8d.

12117. **Electric current motors.** Hartmann and Braun. 8d

12257. **Electric incandescence lamps.** Scharf and Latzko. 8d.

12960. **Electric transformers.** Mordey. 8d.

13315. **Arc lamps.** Johnson. (Bellens.) 8d.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Brush Co.	—	3½
— Pref.	—	2
India Rubber, Gutta Percha & Telegraph Co.	10	19½
House-to-House	5	5
Metropolitan Electric Supply	—	10½
London Electric Supply	5	2½
Swan United	3½	5½
St. James'	—	8½
National Telephone	5	4½
Electric Construction	10	7¼
Westminster Electric	—	6

NOTES.

Brussels.—Tenders are received for Brussels on the 30th.

Hove.—The tenders for Hove lighting are to be received on October 26th.

City Mains.—The conduits of the electric lighting mains in the City are now practically complete.

Swiss Telephones. — Telephonic communication between Berne and Geneva is expected by the end of the month.

City of London Company.—Prof. Silvanus Thompson has been appointed consulting electrician to the City of London Electric Lighting Company.

St. Petersburg.—The principal street of St. Petersburg, the Newesky Prospect, is to be lighted shortly for a length of a mile and a half by 38 arc lamps on ornamental iron lampposts.

Auction Sale.—As will be seen elsewhere, an important sale by auction will take place early next month at 39, Queen-street, E.C., of a large quantity and variety of electrical supplies.

Paris Concessions.—The Paris Municipal Council will shortly consider the transfer of the Popp concession for electric lighting, and the prolongation of the gas company's concession.

Personal.—We understand that Mr. C. E. L. Brown, late chief engineer to the Oerlikon Works, has left this company in order to start business on his own account at Baden, near Zurich.

Burton.—Eighteen tenders in all have been received for the lighting of Burton-on Trent. The whole matter is at present under the consideration of the committee, and the tenders are not yet settled.

Frankfort Exhibition.—The number of visitors to the Frankfort Electrical Exhibition has already amounted to over a million. The exhibition will close on October 19. The price of entry until closing will be 6d.

Ilkley.—The Ilkley Local Board are wishing to purchase the gas works, but the negotiations have fallen through. They must either apply for a special Act to compel the transfer or turn their attention to electric light.

Extinguishing the Light.—A story is related about a rancher from out West who, not knowing how to extinguish the light, uncoiled the wire and put the lamp inside a drawer, where it was found burning next morning.

Southend Pier Electric Railway.—The receipts from the electric tramway at Southend for the month of September were £441. 15s. The total of the wages, including the promenade, for the month was £90. 18s.

Electric Railways.—Long lines of electric railway seem to be increasing in the States. A line is to be built from San José, California, to Oaklands, a distance, including branches, of 48 miles. The cost price is given as £100,000.

Pretoria.—The desire for electric lighting is spreading in South Africa, and, besides private plants, we learn that Pretoria is to be lighted early in April next. The installation is, we understand, in the hands of Messrs. Crompton and Co.

Kilkenny.—Messrs. Waller and Manville, of 39, Victoria-street, Westminster, London, S.W., have been retained by the Corporation of Kilkenny to advise them on the suitability of the introduction of electric lighting in Kilkenny.

Paris Telephones.—A large new central telephone exchange is being erected opposite the Paris Hôtel des Postes, in the rue Gutenberg. It is estimated to cost 800,000f. (about £32,000), and will be ready for service at the end of the year.

Harwich.—The town clerk of Harwich has been requested, as already reported, to apply for a provisional order for power to supply electricity for private and public lighting. Messrs. Wilkins, Blyth, Dutton, and Hartley are the parliamentary agents.

Bristol.—The work of construction of the buildings for the Bristol central electric lighting station is carried forward one stage by the recommendation for acceptance of the tender of Messrs. J. Durnford and Sons, £2,989, for the construction of retaining wall at Temple-back.

Hove Church.—The fine new parish church at Hove, Brighton, which was designed by Mr. J. L. Pearson, R.A., is having a complete electric light installation erected, under the superintendence of Messrs. Morgan Williams and King, consulting electrical engineers, Westminster.

The Halifax and Bermuda Cable.—It is understood in Canada that the Canadian Pacific Railway and the Commercial Cable Companies have secured the controlling interest in the Halifax-Bermuda cable, with the view of extending communication to the West India Islands.

London County Council.—No appointment has been yet made as electrical engineer to the London County Council, rendered vacant by the resignation of Mr. W. Arnot. The salary was £200 per annum, but if the only result of getting good men is to lose them, this may be altered.

Lyceum Theatre.—The electric lighting arrangements in the Lyceum Theatre were carried out by Mr. Harry South, of Garrick-street, Govent Garden. The addition of the electric light to this theatre was greatly wanted to perfect the comfort of the auditorium, and is much appreciated.

Canterbury.—It was agreed at the last meeting of the Canterbury Town Council, on the recommendation of the Electric Lighting Committee, that the Brush Electrical Engineering Company be invited to send a representative to Canterbury to arrange terms on which they would take over the order.

Ilfracombe.—It was stated at the last meeting of the Ilfracombe Local Board that a letter had been received from Messrs. S. D. Williams and Co., to ask the Board to consider plans and estimates for the electric lighting of the town. The clerk was directed to say that the matter was under consideration.

Ludlow.—The question of electric lighting the borough of Ludlow was considered at a recent meeting of the Town Council. The Mayor said the Council had the matter in their own hands, as the application of the Electric Lighting Company held good until January. It was decided to adjourn the question.

North London Polytechnic.—An endowment of £1,500 a year has been promised by the Charity Commissioners for the proposed polytechnic for North London, a site for which has been secured in the Holloway-road. A sum of £15,000 is yet required to complete the amount necessary for the buildings and apparatus.

Liverpool Naval Exhibition.—The idea has been promulgated, and seems to meet with some approval, that a naval exhibition should be held in Liverpool. Sir W. B. Forwood, chairman of the Museum and Arts Committee, has ascertained that a large number of the exhibits from Chelsea might be obtained for the Liverpool exhibition.

Birmingham Town Hall.—The Estates Com [illegible] of the Birmingham Corporation are in communic the electric lighting company to see how far a sufficient light can be supplied at a reasonable price, or one low enough to bring it within the reach of the many people who use the hall, so as to do away entirely with the gas.

Lisbon Opera House.—The embarrassment connected with the lighting of the Lisbon Opera House has been overcome. It will be illuminated by electricity, the Portuguese Government undertaking to bear the expense of putting the machinery in working order, and the principal subscribers, including the King, sharing the cost of illumination.

Leeds Electrical Tramway.—We hear from Mr. Graff Baker that he hopes to have the Roundhay Park electric railway opened for traffic in a week or 10 days, and we understand that the formal opening of the first overhead conductor electric railway in Great Britain will be widely attended. It is fixed to take place on the 22nd, when the Mayor of Leeds will attend.

Telephoning Sermons.—On Sunday last a number of ladies and gentlemen attended at the telephone exchange, Loughborough, to hear the service at Christ Church, Birmingham, 60 miles away. Every word was distinctly heard—the sonorous tones of Canon Wilcox reading the lessons, the solo by Master Hulme, and the sermon by the Vicar being all well audible.

Electric Railways for Berlin.—The municipal authorities of Berlin, it is stated, are considering the question of extending the elevated railroad system of that city and suburbs and operating it by electricity. The system under consideration will include eight lines, making a total of 35 miles, and is estimated to cost not less than eighty million marks, or four million pounds.

Maintenance of Accumulators.—A contract for some time under consideration has, we understand, now been definitely arranged by which the makers of accumulators guarantee to undertake the maintenance in good order of cells for traction purposes. This arrangement will, it is believed, result in a considerable extension of accumulator car traction within the coming season.

Rhyl.—A special meeting of the Rhyl Improvement Commissioners, held on Tuesday, discussed a scheme for the introduction of electric light, and the supply of salt water for flushing, at a total cost of £21,700. Mr. W. Elwy Williams presided, and suggested the offer of a premium for the best scheme. It was ultimately decided to refer the consideration of the scheme to the joint committee to report.

Dover.—The agreement for Dover lighting contained a tender for lighting the sea front and the streets to the Market-place for £1,245 a year with lamps, two chains apart, giving twelve times the present light. An alternative tender was for £650 with lamps, 90 to 100 yards apart, as at Eastbourne or Hastings; this would be four times the present illuminating power at 50 per cent. more than the price of the gas.

Bideford.—The gas company of Bideford are understood to have the intention of applying for a provisional order for additional gas supply. The Bideford Town Council at their last meeting determined to oppose it, and the desirability or otherwise of purchasing the gas works was referred to the committee. It would seem a favourable time of raising the question of an electric light instead of a gas provisional order.

Leamington.—The Town Council of Leamington are not to be left without further dealings with electric light, as we notice that at the last Council meeting the Watch Committee reported having received a notice from the Aurora Electric Lighting and Distribution Company of their intention to apply to the Board of Trade for a provisional order to supply electricity for lighting and other purposes in the borough.

Kingswood.—A resolution was passed by the Kingswood Local Board last week with reference to the electric lighting, that Messrs. Parfitt and Sons be permitted to erect poles and wires for the purpose of lighting the district known as the lighting area of the Board, such poles to be placed at positions pointed out by the surveyor; if the said lighting is not carried out, the poles are to be removed upon notice from the Board.

Bradford Town Hall.—It was decided by the Bradford Town Council on Tuesday, on the recommendation of the Finance and General Purposes Committee, to accept the tender of Messrs. Andrews and Preece, Limited, for the providing and fixing of fittings required in the lighting by electricity of rooms in the municipal buildings, for the sum of £898, exclusive of fittings to be provided by the Corporation, at an estimated cost of £450.

Bradford.—Alderman Priestman, in answer to a question by Mr. Freeman, at the Bradford County Council meeting on Tuesday, said he thought it would be possible to supply the Allerton district with the electric light; and if the manufacturers and tradespeople there would petition the Corporation and promise to take the supply of electricity, it might be the means of bringing the gas company to agree to different terms as the gas supply to Allerton.

Dunoon. — At the Dunoon municipal meeting on Tuesday, the practicability of erecting a telpherage wire from the Castle Hill across the firth to an eminence behind the Cloch Lighthouse, the mail bags to be propelled across by electricity, was considered, but it was ultimately agreed to write to Mr. Redford asking him to communicate with the Hafton Trustees as to what arrangements they were willing to make for ferrying the mails from the Cloch.

Electric Tuning-fork.—The French theatres, by a decree dating from 1859, have their musical note "la" fixed at 870 double vibrations per second. MM. Guerre and Martin have produced an electric tuning-box for the use of instrumentalists, bandmasters, and leaders of orchestra. This box contains a dry pile connected to an electromagnet. This, fixed to a sounding-board, gives the required note on moving a small commutator placed outside the box.

Board of Trade Testing Laboratory.—We called recently to see the state of the Board of Trade testing laboratory at Richmond-terrace, Whitehall, which is being prepared under the superintendence of Mr. Rennie, late assistant to Sir William Thomson. The laboratory is in a forward state, but the testing instruments are still awaiting the result of the Cambridge experiments. Further information as regards this important laboratory will probably be forthcoming shortly.

New Printing Telegraph.—The *Times* of Thursday announces the trial of a new telegraph instrument, the invention of Herr Jaite, director of telegraphs, which seems to be a modification of the Wheatstone instrument, punched holes being formed in the shape of letters. A trial between Berlin and Hamburg, 200 miles, gave a speed of 65 to 85 messages an hour, 25 to 35 words a minute. The advantages are ease of working and direct reading of message in roman characters.

Manchester.—The site for the Manchester hydraulic and electric station is about 4,100 square yards, of which 25,000 square yards is for electric lighting. The price for the site is £15,900. The system of distribution recommended by Dr. Hopkinson is on the five-wire system, with pressures of 400 volts in the extreme conductors down to 100 volts in the service mains. As the first practical example of the five-wire system in England, the Manchester installation will have great interest for electrical engineers.

Consulting Engineers.—Messrs. Morgan Williams and Frank King, whose commencement as consulting engineers we announced last week, are acting in this capacity to the Sydenham electric lighting station, now being carried out by Messrs. J. E. H. Gordon and Co., Limited. We believe they are also engaged in investigating and reporting upon a scheme for lighting a tunnel two miles long on the Rhondda and Swansea Bay Railway, and for lighting the trains by the use of neighbouring water power.

St. Helens.—Tenders are invited for erection of certain appliances and machinery for the supply of electricity to the Town Hall, St. Helens. Plans may be seen and specification and form of tender obtained on application to Mr. G. J. C. Broom, A.M.I.C.E., the borough engineer, on payment of one guinea, which will be returned on receipt of a *bona fide* tender. Sealed tenders to be sent in by 21st inst., addressed to the Chairman of the Parks, Markets, and General Purposes Committee, and endorsed "Tender for Electric Light, Town Hall."

Blackpool.—The Blackpool town councillors are determined to do something practical with reference to the electric lighting question at once. At the last meeting Councillor Pearson was appointed chairman of the Electric Lighting Committee, and it was resolved that a short statement of particulars of electric lighting in selected towns be prepared under the directions of the chairman, Councillor Sergenson, and the town clerk; also that those members of the committee who can make it convenient should visit the towns so recommended by the sub-committee.

Fatal Accident at Lauffen.—We regret to learn that on Monday one of the engineers employed at the Lauffen generating station met with a fatal accident through touching a wire through which a high-tension current was passing. The deceased, whose name was Rau, was discovered lying dead on the floor of the transformer-house by the engineer-in chief. It appears that Rau, in defiance of the instructions given him, entered the transformer-room to attend to a defective lamp, and coming into contact with a high-tension wire was killed instantaneously.

Jensen Electric Bells. — We are informed by Messrs. Woodhouse and Rawson United, Limited, that Messrs. Hans Jensen and Jens Jensen, hitherto branch managers of the business carried on at 2, Gray's-inn-road, under the name of the Jensen Bell and Signal Company, are no longer connected with the company directly or indirectly. The whole of the patents are the property of Woodhouse and Rawson, and the bells will continue to be manufactured as before. It is intended to remove the business to the Cadby Hall Works, Kensington.

Telephone Charges.—A correspondent in the *Scotsman*, referring to the application of the Caledonian Telephone Company, of Glasgow, for a license from the Post Office to run telephone exchanges, expresses a hope that the license will be granted, as the public will then have the advantage of cheapness and efficiency, these coming with competition. He mentions that in Paisley an exchange connection is obtainable for £5 a year, and where two people use the same wire, each having their own instrument the expense is the mere trifle of £3 a year each.

Ulverston.—The Ulverston Local Board would probably be grateful for a little definite information as to the cost of electric lighting. It is necessary to do something to keep their provisional order, but they do not wish to absorb the dwindling profits of the gas works. One member expressed an opinion that electric plant for Ulverston would cost £100,000! With the use of water power one or two thousand should do a great deal. The clerk is to communicate with the Board of Trade, and report again as to the steps to be taken to put the provisional order in force.

Teaching Languages by Telephone.—What are we coming to next? The question of teaching languages must indeed be pressing, if what is stated is not a joke. The French Minister of Public Instruction—noting that in learning English it is the pronunciation that is the most difficult part—has decreed, in accordance with arrangements made with the Minister of Posts and Telegraphs, that after the 15th October the Paris-London telephone line is to be placed at the disposal of students of languages. Other international lines as erected are to be used in the same way.

Sherborne.—Mr. E. R. Dale has been exhibiting the Maquay system of lighting by primary batteries with considerable success, fitted up in a tent at the rifle camp and at the water works, Sherborne, Dorset. An instance of the extended demand for small lamps is given in the fact that one firm ordered this week over £200 worth of the Maquay bicycle lamps. Mr. Dale is, we understand, fitting up a dynamo and waterwheel in another part of the town, and is also intending to hold a local exhibition with an improved gas engine, dynamos, and electric fittings. Exhibits on commission will be included of other makers' goods.

Fire at Bournemouth Telephone Exchange.—It is not often we manage to set telephone exchanges on fire in England, but a case happened during the recent storm. About nine o'clock on Tuesday night a fire suddenly broke out in the switchroom at the Bournemouth central exchange of the Western Counties and South Wales Telephone Company. The whole apparatus became suddenly alight, and the night operator states that he had a narrow escape. He attributes the fire to the contact of the overhead electric lighting wires, caused by the boisterous wind that was prevailing. The fire was extinguished.

Grays (Essex).—The Grays Local Board have before them the question of improvement in the town lighting, and a report has been furnished by Mr. A. W. Boatman and Mr. J. Golden. The terms offered by the gas company were considered too high. The committee think it would be advisable to have the entire control of the lighting under the Local Board, and suggest that, as the Board are about to erect a pumping station for the sewage works, it might be well to erect machinery at the same time and light the town by electric light. The question was adjourned, and a copy of the report was ordered to be sent to the gas company.

Another Blackpool Tramway.—Blackpool is to have another electric tramway, if proposed plans are carried out. At the last meeting of the Blackpool Town Council a letter was received from Mr. C. Chadwell, engineer, of Blackburn, enclosing plans showing the route of the proposed tramway for submission to the Highway Committee. The tramway will commence at Lytham and pass through St. Anne's to Blackpool. The cars will be worked by electricity or the cable system. It is intended to apply for a provisional order next session to construct and equip the tramway, and the Council are asked to assist by assenting to the Bill for obtaining the powers.

Sunderland.—At a special meeting of the Electric Lighting Committee of the Sunderland Corporation, held last Friday, the returns were presented from some eight or ten towns in which provisional orders had been obtained for electric lighting, and some of which had been in negotiation with private companies to take over the supply. None of them, however, had come to any definite arrangement.

After a long discussion it was decided to write to the various large electric lighting companies informing them that the Corporation were open to treat, and asking upon what terms any of the companies would be prepared to take over the powers of the Corporation for a limited number of years. The committee will be called together again as soon as these replies have been received.

Glasgow Library.—Bailie Martin asked a question at the Glasgow Town Council meeting last week with reference to the gas engine supplied to the Mitchell Library for the electric lighting. According to the standing orders of the Town Council no member is allowed to contract directly or indirectly for the Corporation, and he wished to know how a member had got his gas engine into the library. It was explained that the Gas Committee provided the installation, the specification being drawn up by Mr. Cook, the electrical engineer consulted by the committee. The firm who obtained the contract put in an Acme gas engine, which Councillor Burt was interested in. It was not decided whether this fact raised any legal question, and the decision of Sir James Marwick was promised for next meeting.

Efficiency of Accumulators.—In a paper before the Berlin Electrotechnical Society, Herr Ross gave some interesting particulars of the efficiency of accumulators used in the central electric light stations at Barmen, Dessau, and Darmstadt. At Barmen, after one year's service, the efficiency fell to 37 per cent.; repairs to the battery brought it up to 56 per cent. This is bad, but better figures were obtained at Dessau, where, exact measurements having been taken by meter, the efficiency was found to be 85 per cent. The accumulators at Darmstadt only supplied 12 per cent. of the whole output, and the mean efficiency in watts is given as 39 per cent. in 1889; this rose to 60 per cent. in 1890, after a partial overhaul of the cells. These figures show that accumulators (at any rate as used in Germany) are far from perfect, though the mean percentage at Barmen would almost seem to result from some error in measurement. When will our engineers give us similar figures of their accumulator efficiencies?

Walsall Electric Tramway.—At the meeting of the Walsall Town Council on Monday, the General Purposes Committee reported that they had appointed Mr. F. Brown, of the Walsall Electrical Company, to advise as to the terms and conditions upon which the South Staffordshire Tramways Company shall be allowed to erect their overhead wires and work their tramways within the borough by means of electricity, and to superintend the carrying out of the works so as to ensure proper precautions for the safety of the public; and they recommended that the company be allowed to use steam 12 months longer on their lines within the borough, with a view to enable the company to equip their lines for electric traction before the expiration of that period, and that the sum of £500 be accepted from the company in discharge of their liability to repair and maintain the wooden pavement in Bridge-street. The report and recommendation were adopted.

Nelson (Lancs.).—At the monthly meeting of the Nelson Town Council last week the report of the Gas Committee came before the Council. The gas engineer had made a partial and satisfactory canvass of probable customers. The Gas Committee recommended that the town clerk have full authority to prepare agreements for guarantors and also to make application to the Local Government Board for such borrowing powers as might be considered necessary to put in force within the borough the provisions of the provisional order, and the committee recommended the borrowing powers to be fixed at £10,000 Councillors Sunderland and H. Dyson were added to the electric lighting sub-committee. It was stated that the town clerk had been instructed to obtain information as to cost of central station. The minutes were confirmed, and a resolution was passed empowering the town clerk to make application for the sum mentioned for electric lighting purposes.

Bombay.—At a recent meeting of the Corporation of Bombay, says the *Bombay Gazette*, a long discussion arose on the proposal to experiment with a view to ultimately lighting Bombay by electricity. Mr. K. N. Kabraji moved: "That the Commissioner be authorised to invite fresh tenders for electric lighting, as an experimental measure, including a clause for the continuation of such contract as may be agreed upon, or for the purchase of the contractor's plant in the event of the installation proving successful, such lighting being from the Arthur Crawford Market Tower along the Esplanade and Hornby roads to Apollo Bunder, including lighting that market, Church Gate-street, Elphinstone Circle, and the Rajabai Tower." Dr. Balchandra then moved as an amendment that the consideration of the question of electric lighting be postponed, pending the question of the liability of the Corporation as to the cost of the police and other matters being settled, which, on a vote being taken, was carried by 20 to 14.

Electrical Specialities.—A company has lately been formed, under the title of Munro's Electrical Manufacturing Company, Limited, of 9, Holland-place, Glasgow, for the manufacture of electric apparatus and fittings and the carrying out of new inventions. With reference to the latter department, they have a staff of skilled workmen trained for this class of work, having lately worked out and perfected several important and complicated pieces of mechanism. They are open to take up and develop inventions at any stage, and enter into arrangements with inventors. With reference to the fitting department it is found that for the better class of installations, particularly in country mansions, there is a demand for designs which will not be seen in every second or third house visited, and which are not to be found in trade lists. To satisfy this want, special designs are produced, which will not be placed in lists, of highest design and workmanship, and of real hand-wrought hammered work. Mr. John M. Munro, M.I.E.E., is managing director of the company, and Mr. David Alexander, A.I.E.E., secretary. They have offices in Newcastle, Liverpool, and London, the latter being at 45, Jewin-street, E.C.

Oil Engines.—Electrical engineers may be interested in hearing that orders for Priestman's patent oil engine continue to be received freely for a large variety of purposes. Amongst these may be mentioned an 18-h.p. engine for Messrs. Palmer's Shipbuilding and Iron Company, Limited, besides orders from the Great Western Railway Company, Mr. T. H. Ismay, and others for printing, sawing, and electric lighting. For the past two or three years Messrs. Priestman, at their Holderness Foundry, Hull, have been fully occupied developing oil engines of the horizontal and portable types, and they are now in a position to supply the marine type of oil engine, suitable for propelling launches and barges. Some time ago the authorities of the Manchester Ship Canal (Bridgwater section), after carefully investigating the merits of the system, took a small engine on trial, and after testing the working of this thoroughly, they were supplied with two pairs of 10-h.p. engines, which have now been in regular use for some months. The Grand Canal Company of Ireland, after inspecting these engines, have also ordered engines of a similar size. We understand that a launch, 28ft. by 6ft. by 3ft. 6in., fitted with a pair of 5-h.p. engines, can be inspected at Hull by appointment. Oil engines for private country lighting are being largely supplied.

Preston.—The Preston electric lighting company have recently acquired a portion of a cotton mill in Lancaster-road, to convert into a lighting station. The site, which is central, contains about 3,000 square yards, and it is proposed to erect the plant necessary to supply light to the town of Preston, and the present temporary arrangements now at work in Corporation-street will be entirely done away with. The new station will be fitted with six 250-h.p. boilers, and coupled direct to six 200-h.p. engines will be the same number of 2,000-light slow-speed dynamos. The wires now erected overhead in the streets will shortly be taken down, and the mains will be placed underground. Light will be furnished to consumers night and day. A company (the National Electric Supply Company) has been formed for this purpose, with a capital of £100,000 in £5 shares, with 100 founders' shares. The present issue is £60,000. The board will include several local gentlemen. The present installation supplies 2,200 lights with a revenue of £1,320. The company anticipate, judging by orders in hand, a demand of 6,000 lamps at once, and the Corporation has already decided to enter into a contract to light Fishergate.

Telephones in Austria.—Negotiations have been concluded between the Austrian Ministry of Commerce and the Telephone Company of Austria, for the transfer to the State at the end of next year of all the telephone lines at present worked by the company. The company have telephone exchanges in the towns of Prag, Trieste, Graz, Lemberg, Bielitz-Biala, Czernowitz, Pilsen, and Reichenberg. The concessions granted to the company for the first three of these have just expired; that for Lemberg expires in July, 1892, and others in March, 1893. The concessions gave the privileges of selling the plant or of taking it away on expiry. The negotiations just concluded extend the first concessions to the end of 1892, and reduce the others to the same time. The Austrian Government, by payment of an agreed amount, will then take over the whole business. The last balance-sheet of the company showed the gross profits to be £18,513, or, after paying all expenses, £7,857, of which £4,418 were paid as dividends on preference and debenture shares. The working expenses were £7,131, and taxes and royalties paid amounted to £3,520. The number of subscribers on March 31, 1891, was 3,023, and the calls averaged 97,000 per week. The purchase-money to be paid, we are informed by the secretary, is to be £85,000.

Halifax.—At the meeting of the Halifax Town Council last week the minutes of the Gas Works Committee, which were agreed to in their entirety, contained a resolution that the town clerk should be instructed to apply to the Local Government Board for sanction to borrow £60,000 for present and future extensions of the gas works; also to apply to the Board of Trade for a provisional order authorising the Council to supply electricity for public and private purposes within the borough. With respect to the latter item the Mayor said the present electric lighting company supplied electricity from their premises in The Square. The capacity of these premises had reached their limits, and the company had no accommodation for further extension. The Corporation had the power at any time to take over the plant and works of the company and pay them out, and to establish works of their own. Under these circumstances the company had suggested that the present time was a favourable one for the Corporation taking over the establishment. They had obtained a report from Mr. J. H. Woodward, of the Electric Corporation, Limited, and he recommended the premises owned by the Corporation in Stead-street as a central station. It would, of course, be some twelve months before anything could be done in the matter, but before any step was taken the matter would be fully discussed by the Council. The minutes were passed. The complete report was given last week.

Electric Crane Working.—At the time of their installation, we were pleased to give an account of electric cranes erected on a wharf in the City-road, London, by Mr. W. D. Sandwell, engineer to the Victor Engineering Works, Victor-road, Holloway. With reference to these cranes, the following facts and figures as to economy of working deserve especial notice. There were on the wharf a 10-ton steam crane, a two-ton steam crane, and two 30cwt. hand cranes. The cost of coal for driving the two steam cranes only was £250 per year (nearly £5 a week), steam having to be kept up night and day. All four of these cranes were fitted with electric gear, and a dynamo was put down, with all necessary wiring, switches, and safety fittings, the total cost being £300. A gas engine used for chaff-cutting drives the dynamo, and the cost of the gas for the whole of the work—cranes, chaff-cutter, and corn-crusher, besides an ordinary friction hoist—has only been £56 for the year, a little over £1 a week, while the amount of the work done has been considerably in excess of any previous year. The engine is a 12-h.p. Crossley's Otto gas engine. A considerable reduction on fire insurance premiums is obtained at the same time, in some cases as much as 50 per cent. The cost of repairs and renewals for the year has been £5. 3s. It may be taken that the cost of fitting an ordinary 30cwt. crane with electric gearing is about £60, including everything but the engine. The future for the application of electric motors for the driving of cranes seems from these figures to be extremely promising, and Mr. Sandwell is to be congratulated on the results.

Gulcher Electric Light Company.—During the last six months the business of the Gulcher Company has made very important progress. We understand that Mr. de Castro, their chairman and managing director, who has been making a long visit to New Zealand, has succeeded in largely extending the business of the company in that colony. The street-lighting installation at Wellington, which has been working most satisfactorily for some three years, is now to be extended to include the supply of about 3,000 lamps to private consumers. Bills have also been passed through the New Zealand Parliament for the lighting of Christchurch, and other important towns will follow in the immediate future. The general installation work of the company in New Zealand is also largely increasing. In the meantime an important order for a central station with plant for a first instalment of about 2,600 incandescent and 60 arc lamps has been secured, and will very shortly be in operation for lighting part of the city of Genoa. A branch establishment of the Gulcher Company has been inaugurated in this city, and a number of subsidiary orders have been already secured by the company in Italy. In London, also, the company are busy with installations of more or less importance, including the lighting of the People's Palace at Mile End-road, and a large contract recently secured for the lighting of "Modern Venice" at Olympia, West Kensington, are also in hand. The company have lately opened a showroom and offices, 139, Queen-Victoria-street, and altogether we are glad to hear that their business during the last 10 or 12 months has made rapid progress, and that the company is now in a more flourishing condition than it has ever previously been in. The large installations at the Spanish, French, and German Exhibitions, which they have so well carried out at Earl's Court, coupled with energetic management, have doubtless conduced in some measure to this result.

ON THE RELATION OF THE AIR GAP AND THE SHAPE OF THE POLES TO THE PERFORMANCE OF DYNAMO-ELECTRIC MACHINERY.*

BY HARRIS J. RYAN.

The object of this paper is not to deal with the subject in a new light, but to add to its literature a limited amount of data, the deductions from which go to establish the correctness of the ideas, and the utility of the suggestions put forth in the papers read by Messrs. Swinburne and Esson, at the meeting of the Institution of Electrical Engineers, on February 13 and 20, 1890. Up to the time of the publication of these papers the air gap was usually treated by contributors to electrical literature as an evil in a dynamo, having a necessary existence, and the smaller that it could conveniently be made the better. The shape of the poles had often been spoken of as having a somewhat decided effect on the performance of the dynamo, while but little had been said regarding the cause of such an effect.

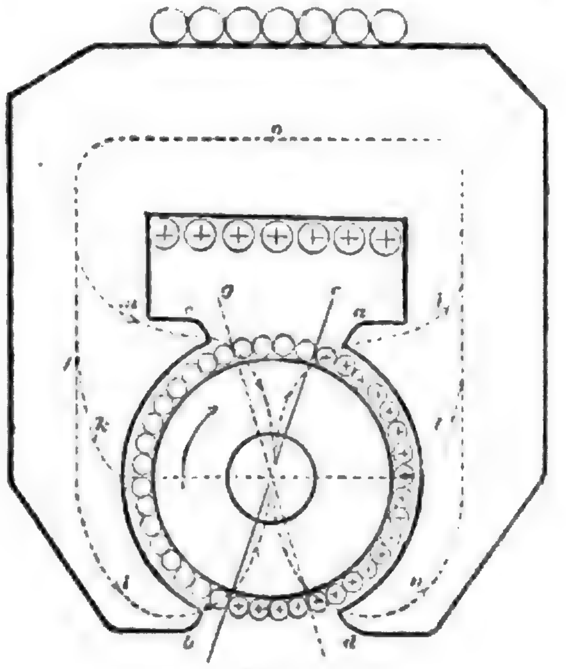

FIG. 1.

There exists some difference of opinion as to what should be known as the number of ampere-turns on an armature.

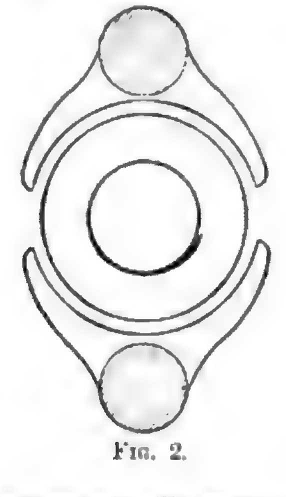

FIG. 2.

For our present purpose we will assume that the armature ampere-turns equal

$$\frac{\left.\begin{array}{l}\text{The number of conductors}\\ \text{on the surface of the arma-}\\ \text{ture}\end{array}\right\} \times \left\{\begin{array}{l}\text{Strength of current in the}\\ \text{armature conductors}\end{array}\right.}{\text{Number of poles.}}$$

Referring to Fig. 1, it is evident that, when we consider the magnetic forces acting in a working dynamo by the route O, I, J, O, the entire number of ampere-turns on the armature are directly opposed in action to the ampere-turns on the field. By the route O, M, N, O, all the ampere-turns on the armature, except those that lie between the double angle of lead G E are acting with the field ampere-turns, while those between G E are opposed to the same. Therefore, by this route, the total number of ampere-turns actually aiding the field ampere turns is the total number of armature ampere turns, minus twice the number of ampere-turns that lie between the double angle of lead. By the route O, K, L, O, the number of ampere-turns acting is the number of ampere-turns on the field, minus the number of ampere-turns that lie between the double angle of lead. We can then estimate with ample practical accuracy the magnetic density in the air gap at all points for any given total amount of magnetisation through the armature. The ampere-turns that lie between the double angle of lead are opposed to the action of the field ampere-turns at all points. It is evident that the portion of the armature ampere-turns not included between the double angle of lead will increase the magnetisation through the air gap by the route O, M, N, O, just as much as they diminish it along the route O, I, J, O, as long as magnetic saturation does not take place in the strengthened pole corners, C D. If the pole corners are thin, as in the types shown in Figs. 2, 3, and 5, saturation is apt to occur. It is then that the magnetic resistance increases by the route O, M, N, O, and the magnetic density by this route is no longer increased by the same amount that it is diminished along the route O, I, J, O. On the other hand, when the pole corners are fashioned, as seen in Figs. 4 and 6, so that saturation in the strengthened pole corners cannot occur in practice, the current in the armature can produce no modification of the total amount of magnetisation through it other than that which is produced by the action of the ampere-turns that lie between the double angle of lead

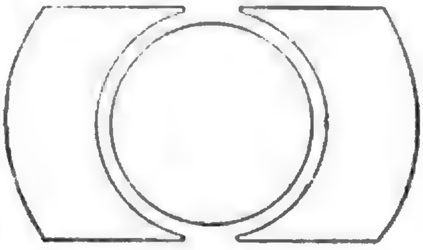

FIG. 3.

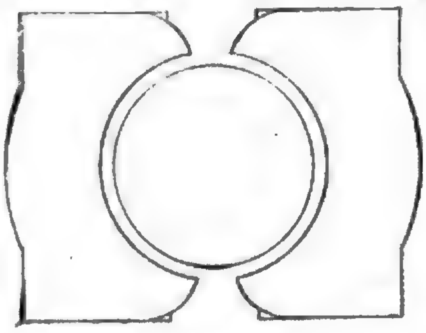

FIG. 4.

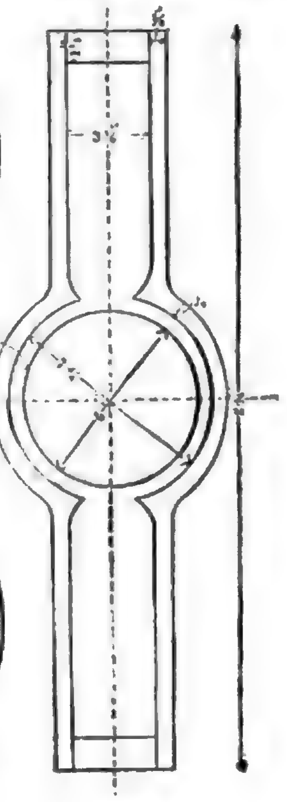

FIG. 5.

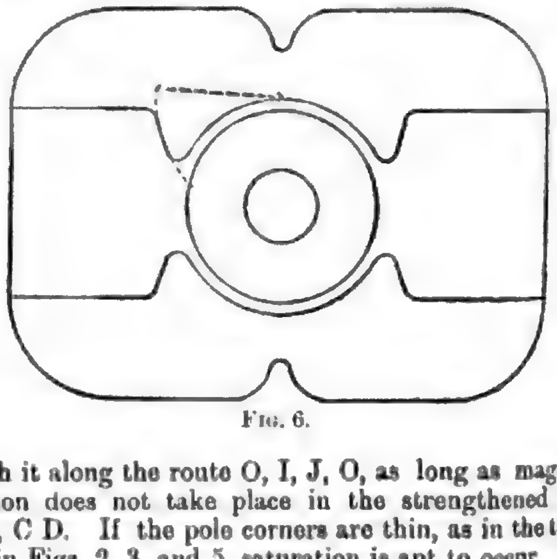

FIG. 6.

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* Paper read before the American Institute of Electrical Engineers, New York, September 22, 1891.

This action can always be compensated for by putting an equivalent number of series ampere-turns on the field acting with the field ampere-turns. The double angle of lead can be determined with sufficient accuracy, for with pole corners slightly extended at the centre (see Fig. 11) the diameter of commutation at all loads is very near the weakened pole corners. The pole corners are slightly extended at the centre, so that the coils always enter the field of the weakened pole corners gradually. The E.M.F. developed in the coils as they pass under the poles can never be far different from that actually needed to reverse the current in the coil when passing under the brush. In this way the point of commutation in a dynamo can be kept the same when carbon brushes are used without undue sparking, as long as the armature does not reverse the magnetisation under the weakened pole corners.

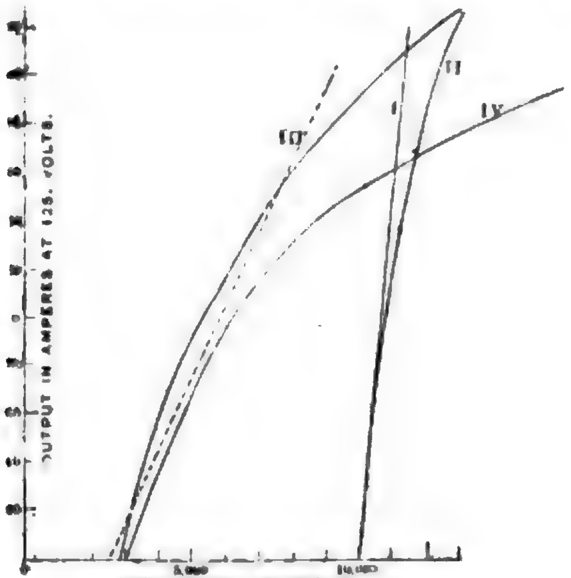

Fig. 7.

From the discussion of the magnetic relations of an armature to its field in a dynamo, in connection with Fig. 1, it is seen that the magnetisation in the air gap under the weakened pole corners becomes zero, when the armature ampere-turns are equal to the ampere-turns on the field, whose magnetising force is impressed between its pole faces through the armature. This impressed magnetising force is that due to the difference between the total number of ampere-turns on the field and the number of ampere-turns required to set up the magnetisation through the field cores, from pole face to pole face. In order to commutate the current without spark at the commutator the magnetisation in the air gap under the weakened pole corners dare never be allowed to become zero. It follows, then, that the field ampere-turns, impressing a magnetising force between the pole faces, must always be somewhat in excess of the maximum number of ampere-turns on the armature. The amount of this excess need only be sufficient to ensure a positive field at A and B, Fig. 1, strong enough to reverse the current in the coils as they are commutated. When a certain amount of magnetisation is to be set up through an armature, with the application of the magnetising force of a given number of ampere-turns impressed between the pole faces, we must provide the requisite amount of magnetic resistance between these pole faces. The value of this resistance will have to be such that the impressed field magnetising force will establish the desired amount of magnetisation. This resistance in most cases is best provided for in a proper length of air gap. In general it is found best to avoid heating in the armature core, as far as consistent, by the use of comparatively low magnetic densities for wrought iron. The magnetic resistance of the armature core, under these circumstances, is very small and may be neglected.

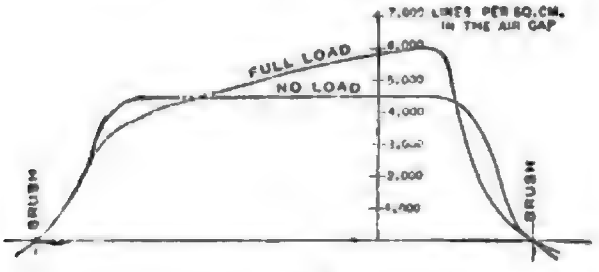

Fig. 8.

The magnetic resistance between the pole faces is occasionally provided for largely, either through a saturated core of a ring armature, saturated lugs on armatures where the wires are placed in grooves, or both. This, in addition to what air gap may be necessary from a mechanical point of view, go to make up the total amount of magnetic resistance that is provided between the pole faces. Machines of this order have been developed largely through the old and rather expensive method of experimentation. This method has given us some types in which ordinary results are arrived at through rather extraordinary means. Take the case of a machine with a ring armature, wires wound in grooves, a very small air gap, and poles shaped somewhat as shown in Fig. 2. Such a machine, operated as a dynamo, may require only a quarter of the number of ampere-turns that it will have on the armature at full load for field excitation in order to produce a certain E.M.F. at a given speed. Yet this machine produces a fairly constant potential at the brushes under all variation of load, and without undue sparking at the commutator, in the following manner: For the production of a constant E.M.F. at constant speed the total magnetisation through the armature must remain constant. At no load, one-fourth of the ampere-turns needed on the field at full load are provided by a shunt winding. This shunt winding is sufficient to set up the total amount of magnetisation for the production of the normal E.M.F. of the machine when there is no current in the armature. Now, in order to take the normal current from the armature without reversing the magnetisation under the weakened pole corners, three times as many series ampere-turns as there are shunt ampere-turns must be added to the field. The addition of these series ampere-turns must not increase the total amount of magnetisation through the armature, which is accomplished by the thin pole corners. The strong pole corners become saturated when the armature is furnishing even a small amount of the normal current for which it is designed. For most values of the current, then, the armature ampere-turns tend to diminish the magnetisation under the weakened pole corners, but cannot increase it correspondingly under the saturated pole corners. The action of the series ampere-turns on the field prevents the reduction of the magnetisation under the weakened pole corners to zero, while the saturated portion of the pole-pieces

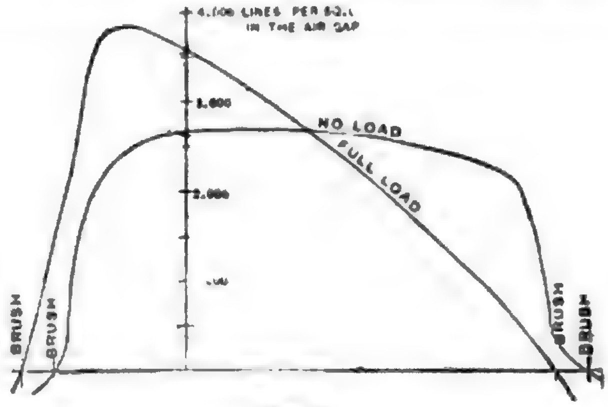

Fig. 9.

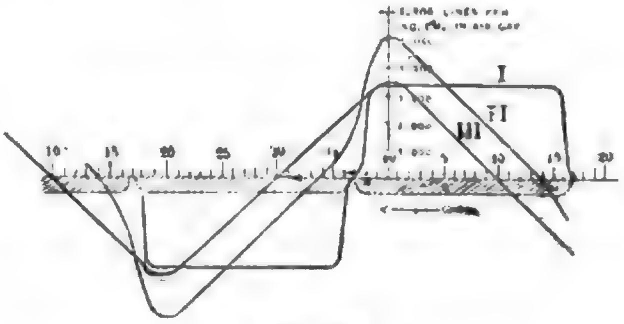

Fig. 10.

prevents the increase of the total magnetisation through the armature, and thus a constant potential is maintained.

The "armature characteristic" IV., plotted in Fig. 7, was taken from the machine of the above sort, built with cast-iron fields. The cross-section of the field cores proved on trial to be too small, and became strongly saturated at full load, while they were quite a little under the point of saturation at no load. This curious result for a constant-potential generator was due to the increased magnetic leakage produced as the series ampere-turns on the field came up with the load. Saturation took place, as the curve indicates, when the armature furnished a current of about 140 amperes, and no possible compounding could ever make this generator produce even approximately a constant potential, with variation of load. Steel cores of the same dimensions were substituted for the cast-iron cores. Saturation did not occur in them due to magnetic leakage. The pole corners were very thin, as in Fig. 2, and the "armature characteristic" III. was obtained. The machine was then furnished with a shunt winding that produced a slightly smaller number of initial ampere-turns than Curve III. indicates as required to produce 125 volts, and with series-turns at such a number that the total number of ampere-turns on the field for any current developed by the armature is shown by the broken line drawn through Curve III. It was under these conditions that the machine performed in the manner described above, and not vary more than 5 per cent. from the normal E.M.F. on either side, or a total variation of 10 per cent. It was then almost entirely rebuilt. The armature was provided with a core that was considerably larger in cross-section, and the maximum magnetic density used in it was 11,000 lines per square centimetre, as against 20,000 used before. The lugs on the core were dispensed with and the wires wound on the surface of the core. The poles were made of cast iron, and fashioned to accord more nearly with those in Fig. 3. The air gap required 10,000 ampere-turns to set up the magnetisation through it at no load, while the armature ampere turns were 8,000 at normal output, so that series ampere-turns had only to be added to counteract the action of the ampere-turns on the armature that lie between the double angle of lead, to increase slightly the E.M.F. by the amount equal to the fall of potential through the armature caused by its resistance, and to compensate for the slight effect of the pole corners that still became saturated to a limited extent for the higher outputs. It should be remembered that the magnetic leakage that takes place between the adjacent north and south pole corners, one of which is strongly and the other weakly magnetised, plays an important part in saturating thm pole corners. It is evident that unless the "armature characteristic" is a straight line, as in Curve I., Fig. 7, that the machine cannot be made to regulate for constant potential with a high degree of refinement. The poles were again changed and shaped as in Fig. 4, when an "armature characteristic" given in Curve I. was obtained and the proper number of shunts and series ampere-turns for a refined degree of regulation were readily decided upon. These experiments confirm what has been said above, and show how useless have been the attempts to diminish the air gap beyond certain limits.

It was shown on the outstart how we can calculate the actual magnetic densities in the air gap for any total magnetisation through the armature for any armature current. The results of the following experiments confirm the correctness of these methods. The diagrams in Fig. 8 give the values of the magnetic density at all points of the air gap of a generator producing 125 volts at the brushes and 80 amperes. The following are its dimensions and data :

Diameter of armature core	6·25in.
Length of armature core	12· in.
Diameter of bore of poles	7·19in.
Double depth of air gap	·94in.
Armature sections	50.
Turns per section	2.
Resistance of armature	·06 ohms.
Poles shaped as in Fig. 3.	
Shunt-turns on field	6400.
Field current, no load, 125 volts	1·48
Field current, full load, 125 volts	2·10
Speed	1600.
Carbon brushes used without lead.	

The "armature characteristic" curved considerably, indicating that the pole corners become saturated. It is evident, too, that the normal magnetisation in the pole corners, in addition to the magnetic leakage, which is greater there than anywhere else, produced saturation in all pole corners, even with no current in the armature. For, at full load, there were 4,000 ampere-turns on the armature, while 4,000 series ampere-turns had to be added to the field that produced 125 volts at no load to keep the E.M.F. the same. Therefore, at full load we have the same number of ampere-turns acting through the weakened pole corners as at no load, and the total amount of magnetisation has only been increased 5 per cent. to compensate for the resistance of the armature conductors. The conditions, however, are not the same, for there are just 4,000 more ampere-turns to cause magnetic leakage at the pole corners, so that on the whole the magnetisation in them is increased. This increase of magnetic density in them greatly increases their magnetic resistance, for they are saturated to begin with. It is on this account that we find the magnetisation under the weakened pole corners diminished when apparently the forces acting have not been changed. The magnetisation under the strengthened pole corners through the air gap is increased more than it is diminished by the effect of the added magnetic leakage through the 8,000 additional ampere-turns, that act to produce magnetisation by this route through the armature.

In Fig. 9 the diagrams show the magnetic action of the armature of a 10-h.p., 110-volt motor, with poles fashioned as in Fig. 6. Measurements of the magnetic leakage were made on this motor, and the results indicate that the shape given to the pole corners avoided saturation in them even at full load. The double angle of lead was almost 60deg. The ampere-turns embraced by it on the armature were partially compensated for by nine series-turns on each of the consequent fields. The remainder of the armature ampere-turns that lie between the double angle of lead served to weaken the field by just the amount required to produce a constant speed. The following figures give additional data on this motor :

Diameter of armature core	8·33in.
Diameter over all	9· in.
Bore of poles	9·38in.
Double air gap	1·05in.
Shunt-turns on field	2200.
Shunt current at 110 volts	3·55.
Ampere-turns on field at 110 volts	7800.
Ampere-turns on armature at full load	5750.
Armature sections	48.
Turns per section	3.
Speed	1200.

The ampere-turns required to set up 2,600 lines per square centimetre through a distance of 1·05in. or 2·64 centimetres in open air

$$\frac{2{,}600 \times 2{\cdot}64}{1{\cdot}26} = 5{,}600.$$

This is the number of field ampere-turns that exerted their magnetising force between the pole faces through the armature. The ampere-turns, acting through the weakened pole corners, are therefore very near zero, which is entirely corroborated by the fact that the magnetisation was observed to be zero at this point. See full load curve in Fig. 9. Through the strong pole corners the ampere-turns acting were the 5,600 of the shunt ampere-turns + the 720 of the nine series-turns + the armature ampere-turns, 5,750—twice the ampere-turns between the double angle of lead, 2 [·3 × 5,750], or 3,400 = 8,670, which will produce a magnetic density through an air gap of 2·64 centimetres depth of

$$\frac{8{,}670 \times 1{\cdot}26}{2{\cdot}64} = 4{,}100,$$

while the actual magnetic density measured at this point was 3,950, an agreement within the possible limit of error.

In Fig. 10 are given curves showing the magnetic performance of an armature, with its conductors laid in deep narrow grooves, as shown in Fig. 12. The clearance on each side was $\frac{1}{16}$in., making the double air gap ⅛in. Additional dimensions are as follows :

Diameter of the armature core	6· in.
Length of armature core	6· in.

Resistance of armature	·34
Number of sections	64.
Turns per section	3.
Output amperes	20.
,, volts	100.
Speed	1,000.

Curve I. in Fig. 10 shows the distribution of magnetisation at 112 volts, no current, a speed of 1,800, and a field excitation of 2,600 ampere-turns. Curve II. shows the magnetic distribution for an output of 97 volts and 24 amperes, at a speed of 1,800, and a field excitation of 2,600 ampere-turns. Curve III. shows the magnetic distribution at an output of 40 volts and 20 amperes, at a speed of 1,800, with a field excitation of 750 ampere-turns. This same excitation, when the armature furnished no current, produced an E.M.F. of 48 volts, at a speed of 1,800 revolutions. The poles were shaped as in Figs. 11 and 12, but modified as explained below. In making these experiments carbon brushes were used, and their position maintained at the normal diameter of commutation. An average magnetic density in the air gap of 3,400 lines per square centimetre was required to produce an E.M.F. of 112 volts. The grooves on the armature in which the conductors were placed occupied one-half of the armature surface, so that the actual magnetic density in the air gap was 1·8 times this average magnetic density. The ampere-turns required to set up this magnetic density in the air gap were

$$\frac{\cdot 125 \times 2\cdot 54 \times [3{,}400 \times 1\cdot 8]}{1\cdot 26} = 1{,}520,$$

which is the number of field ampere-turns, whose magnetising force is impressed between the pole surfaces through

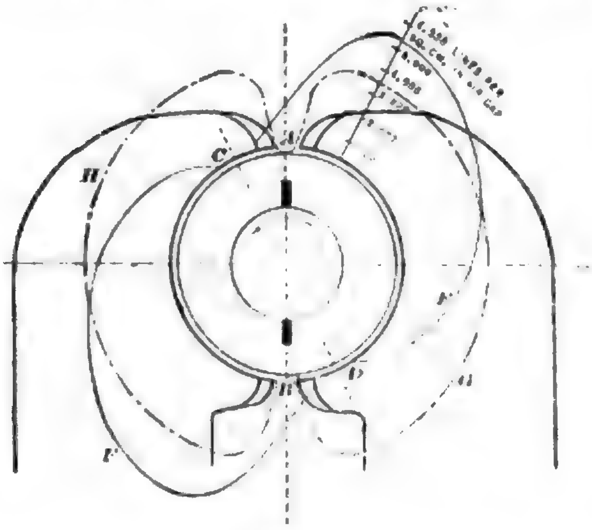

FIG. 11.

the armature, when it furnishes 112 volts and no current. The ampere-turns on the armature at a current of 24 amperes are

$$\frac{2 \times 64 \times 3 \times 12}{2\cdot} = 2{,}300,$$

as against 1,520 impressed by the field. Under these circumstances, the magnetism under the weakened pole corners is reversed, as is also clearly indicated by Curve II. in Fig. 10, or the curve C, E, D, F, C, in Fig. 11. This curve also shows that the magnetic density under the strong pole corners was 5,100 lines per square centimetre. Now in building this machine, six longitudinal slots, 1¼in. deep, were cut in each pole immediately back of the surface, which enables us to be sure of the exact densities in the pole corners for a given distance. For a depth of 1¼in. immediately back of the pole faces these slots took up one-half of the cross-section of the poles. Then a density, therefore, of 5,100, really means a density of 10,200, or a strong saturation for a distance of 2½in. in the cast iron of the poles. The magnetising force required to produce 10,200 lines per square centimetre through cast iron is 200 per centimetre length. Therefore, the ampere-turns required to establish this density through 2½in. are

$$\frac{2\cdot 5 \times 2\cdot 54 \times 200}{1\cdot 26} = 1{,}000.$$

The total number of ampere-turns acting to produce magnetisation through these strong pole corners was the sum of the field ampere-turns that impressed magnetising force from pole face to pole face through the armature, and the ampere-turns on the armature covered by the poles. The poles covered approximately 85 per cent. of the armature surface, making this value $1{,}500 \times [2{,}300 \times \cdot 85] = 3{,}400$. Of this number, as was just shown, 1,000 were utilised in producing the magnetic density of 5,100 through the saturated portion of the poles. The remaining 2,400 ampere-turns exerted their magnetising force in producing the average magnetic density of 5,100 through the air gap, and affords another opportunity of checking these ideas of the action of the armature on the field. For the ampere-turns required to set up an average magnetic density of 5,100 through the air gap under consideration were:

$$\frac{[1\cdot 8 \times 5{,}100] \times \cdot 125 \times 2\cdot 54}{1\cdot 26} = 2{,}300.$$

which checks with the above value as well as could be expected. When the armature furnished 24 amperes, the E.M.F. at the brushes was 97 volts, while with no current it was 112 volts. Of this drop of 15 volts, eight are accounted for by the resistance of the armature and the extra seven were caused by the saturated pole corners. By operating this same machine at an E.M.F. at which the pole corners could not saturate with normal output of

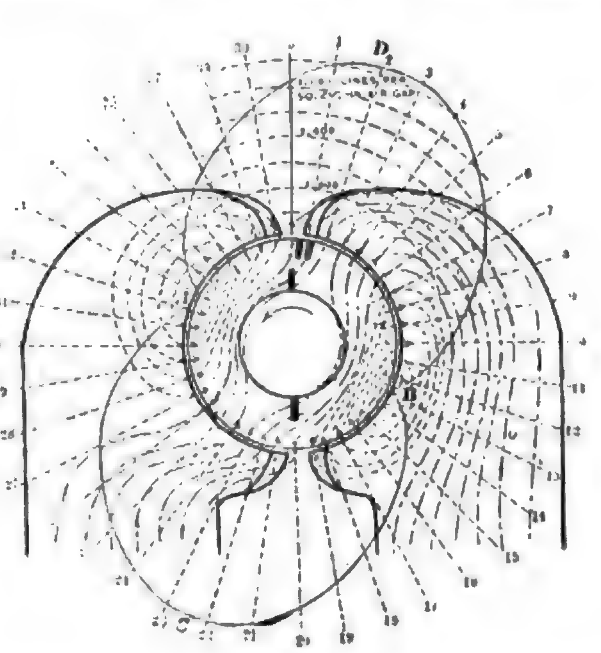

FIG. 12.

current, we have demonstrated for us in a very striking manner that the armature ampere-turns cannot change the total magnetisation established through the armature by the field when the pole corners do not saturate. The E.M.F., with the armature current at zero, was brought to 48 volts with a separate field excitation of 750 ampere-turns. Then when the armature was allowed to furnish 20 amperes the E.M.F. at the brushes dropped to 40 volts. Of this drop of eight volts seven were produced by the resistance of the armature. Yet the field is powerfully distorted by the armature current, as may be seen by reference to Curve III., Fig. 10, or the curve A, D, C, B, in Fig. 12. Even with this very great rearrangement of the magnetisation produced by the armature current, the total magnetisation set up by the field is practically unchanged. The difference of potential on the commutator between the points A B, Fig. 12, was observed to be 72 volts. This excess of E.M.F. over that which was produced at the brushes, the figure shows clearly to be due to magnetisation produced by the armature through itself and the strengthened pole corners. The points where the field is zero are at A B. They mark the diameter through which the ampere-turns encountered on the armature are just equal and opposite in action to the ampere-turns of the field that impress a magnetising force between the pole faces through the armature. A simple computation will show that this is true. The field ampere-turns that impress magnetising force between the poles when the armature produced an external E.M.F. of 48 volts are

$$\frac{1{,}520 \times 48}{112} = 650.$$

The ampere-turns on the armature opposed to the magnetisation set up by the route A B are $\frac{12}{40}$ of the total number of ampere-turns on the armature (see Fig. 12) or

$$\frac{12 \times 64 \times 3 \times 20}{40 \times 2} = 576.$$

This is a fair agreement when we consider the accuracy with which the original data may be determined.

Mr. Esson, in his valuable paper above referred to, discussed the requisite features for a generator of constant current with closed-coil armatures, in which regulation is effected by shifting the brushes. He stated that the field should be uniform at all points under the poles, and that the armature cord should be saturated. These statements are a little misleading. The magnetising force impressed by the field ampere-turns must be uniform at all points between the pole faces. This is accomplished by proportioning the poles so that the strongly-magnetised pole corners will not become saturated when the brushes have their extreme position for the development of the highest E.M.F. that the machine is to produce. The air gap is made of such a depth that the ampere-turns required to set up the magnetisation through the armature, without current, and for the production of the highest E.M.F. that the machine will be called on to give, shall be a little more than the armature ampere-turns when it furnishes its normal current. Then as long as the brushes are kept under the pole faces the non-sparking point will be wherever the brushes are placed. This will be the case whether the armature is or is not saturated. A practical demonstration is found in the following experiment: A Siemens and Halske dynamo, with magnet and armature cores, whose shape and dimensions are shown in Fig. 5, was used.

Length of armature core	7·25 in.
Number of armature sections	56.
Turns per section	6.
Revolutions	1000.
Output in volts	50.
,, amperes	30.

The field was separately excited with 4,000 ampere-turns on each of the sets of consequent poles. Regulation could then be effected for a constant current in the armature of 22 amperes, by shifting the brushes from no E.M.F. to 35 volts without the slightest sparking, even when metallic brushes were used. Within this limit the pole corners did not saturate. The field cores were wrought and the yokes cast iron. When the armature circuit was broken it was found that the field excitation of 4,000 ampere-turns produced an E.M.F. of 50 volts. The magnetic density in the field cores, including leakage, was only 11,000 lines per square centimetre. Therefore, of the 4,000 ampere-turns on the field not more than 200 were applied in setting up the magnetisation from pole face to pole face through the field cores. It is safe to assume, then, that of these 4,000 ampere-turns 3,800 were active in producing a magnetising force impressed uniformly over the pole faces through the armature. This same value is obtained by the method adopted in the previous cases. That is, by calculating the magnetic density in the air gap when 50 volts were developed, and then deducting the number of ampere-turns required to establish such a magnetic density through a 1½in. air gap As to the armature, when it produced 22 amperes its ampere-turns numbered

$$\frac{2 \times 56 \times 6 \times 11}{2} = 3{,}700.$$

or an excess of 100 ampere-turns impressed by the field over and above those on the armature. As long as this same number of ampere-turns was maintained on the field, it was not possible to regulate for a constant current of a lower or a higher strength without sparking. The impressed field ampere-turns are in excess of the armature ampere-turns by that amount which is just sufficient to produce a weak positive field that will reverse the current in the coil when its terminal bars at the commutator pass under the brush. When regulation is effected by this means, it is seen that all pole corners are alike magnetised, and at the centre of the pole faces the magnetisation is zero when the machine is short-circuited. At full output, at the highest E.M.F., the magnetisation under the one set of pole corners is almost zero, and under the other set it is at the maximum value that is ever obtained. In a generator of this type, when the poles are made stout enough at all points, the total amount of magnetisation through the armature at all loads will remain at a constant value.

What has been said of dynamos applies equally well to motors. In a motor the armature rotates in an opposite direction when field and armature currents remain the same as in a dynamo. The E.M.F. of self-induction, caused by the reversal of the current in a current has not changed, while the E.M.F. developed in the coil by the field has changed sign with the change of the direction of rotation. The result is that the reversal of the current in an armature section must take place in a weak field of an opposite sign in a motor from what it does in a dynamo, when sparking is to be avoided entirely.

The action of the current in the armatures of multipolar dynamos and motors will be the same as that found for two-pole machines.

THE DISTRIBUTION OF ELECTRICAL ENERGY.[*]

BY W. C. RECHNIEWSKI.

(Continued from page 105.)

Use of Accumulators.—We return to our district of 500 metres radius and 3,500 lamps.

We have seen that the annual expenses per lamp was 16·15f. per lamp of 10 c.p. for an average of two hours a day, which gives the kilowatt-hour at $\frac{16{\cdot}15 \times 1{,}000}{365 \times 2 \times 40}$ = 0·552f. If the period of lighting was four hours a day for each lamp, all the expenses would remain the same except that of coal, which would be 18,720f., instead of 9,360f. The annual expenditure per lamp would be 18·80f., or $\frac{18{\cdot}80 \times 1{,}000}{365 \times 4 \times 40} = 0{\cdot}322$f. per kilowatt-hour.

The cost price of the light is therefore increased as the number of lamps decreases, provided that the greater part of the expenses remain the same, whatever the number of the hours of lighting.

The use of accumulators allows the energy to be stored during the hours of least load, and the station to be worked at its greatest output.

The accumulators can be used in two ways: 1. The cells can be charged by the dynamos, and the whole lighting can be supplied from them; this is the simplest process, and were it not for the high cost of cells, would be that universally employed. 2. The cells can be charged during the hours of least load, and during the hours of greatest load the cells and dynamos supply the lamps in parallel. This latter method, which is rather more complicated, requires a considerably less number of accumulators.

In the first arrangement the accumulators must supply the whole energy necessary for lighting—namely, 280,000 watt-hours. They must furnish this energy at a rapid rate of discharge—that is, in two hours. In this case the following arrangement will be adopted:

Two batteries will supply the lamps during the hours of greatest demand. Afterwards, one battery will be supplying current while the other is being charged; then this battery will supply current and the first will be charged. Under these conditions, the two batteries must together be able to supply 140,000 watts maximum at a given moment. Taking a capacity of 400,000 watt-hours for each battery, we shall be certain of proper working.

The price of these two batteries will be 86,000f. (£3,440). The efficiency of a good accumulator in actual work may be taken at 70 per cent. It will be necessary, therefore, to supply daily to the batteries 280,000 ÷ ·7 = 400,000 watt-hours, or 600 h.p. A steam engine of 60 h.p. running for 10 hours would therefore be sufficient. A second engine would be required in case of accident.

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[*] Translated from *L'Electricien.*

The first cost of the station and plant will therefore be :

		f.	£
Site, buildings, and offices		33,000	(1,320)
Two sets of 60-h.p. engines, boilers, and pipes	18,000f.		
And 60-h.p. dynamo	6,000		
	24,000f.	48,000	(1,920)
Accumulators		86,000	(3,440)
Switchboards and instruments		10,000	(400)
Total		177,000f.	(£7,080)

The cost of establishment of the central station is therefore 32,000f. (£1,280) higher than that first taken, where no accumulators are used.

The working staff will remain the same. A depreciation and maintenance of 10 per cent. can be taken for the accumulators. Under these conditions the annual expenditure becomes :

	f.	£
Staff	15,400	(616)
Coal, oil, etc.	12,360	(404·4)
Interest on 294,000f. at 5 per cent.	14,700	(588)
Depreciation, buildings and mains, 5 per cent. on 101,200f.	5,060	(202·4)
Depreciation and repairs of plant, instruments, and batteries	13,400	(536)
Total	60,920	(£2,436·8)

$$\text{Say, } \frac{60{,}920\text{f.}}{3{,}500} = 17{\cdot}40\text{f. (13s. 11d.) per lamp.}$$

The expenses are higher than in the first case. On the other hand, the light is better assured against accident to machinery, and can be supplied in case of total breakdown.

In the second arrangement the accumulators and dynamos are always working together: at the time of greatest load both battery and dynamos supply current to the lamps ; as the demand diminishes less is taken from the accumulators ; at half load the dynamos supply the whole current. As the number of lamps decreases, the engines work at the same load, supplying current to the lamps and charging the accumulators at the same time.

A battery of half the capacity of the preceding case will be sufficient, but it will be necessary to add a set of reserve plant, so that the first cost, though less than the former case, will be more than that where no accumulators are used.

The cost will be :

		f.	£.
Sites, buildings, offices		33,000	(1,320)
Two sets of 100 h.p., one being reserve boilers, engines, piping, etc.	24,000f.		
Dynamo of 100 h.p.	10,000		
	34,000f.	68,000	(2,720)
Accumulators		43,000	(1,720)
Instruments, etc.		10,000	(400)
Total		154,000f.	(£6,160)

It is seen that the first cost is hardly more than that of direct working without accumulators, while the whole of the benefits of the latter are obtained.

The principal advantage consists in the more rational working of the station—once the batteries are charged, the machines can be stopped, the accumulators supplying the few lamps which remain alight. In this way, electricity can be supplied, night and day, with a single shift of eight to 12 hours.

Further, the depreciation and maintenance of accumulators are now hardly more costly than that of the plant. There are several large makers of accumulators who will undertake, under forfeit, the maintenance of the accumulators for an annual sum of 5 to 10 per cent. on cost price according to size of battery, which is about the figure usually allowed for machinery.

The use of accumulators is necessary in another case. When an insufficient water power is at disposal, rather than install a steam engine to supplement the turbine, it is better to employ accumulators ; the cost of supply and maintenance are less.

Take a case of a waterfall yielding 200 h.p. while the demand reaches 400 h.p. at time of greatest load. The price of a battery of accumulators capable of supplying 200 h.p. for three hours is, as we have seen, 86,000f. (£3,440). Reckoning 14,000f. (£560) for space and fittings, we arrive at a total of 100,000f. (£4,000), while a station capable of yielding 200 h.p. costs, as was stated above, 145,000f. (£5,800).

With regard to the cost of running, the advantage is yet greater. With accumulators, indeed, only their maintenance and depreciation has to be reckoned. The power supplied costs nothing, while in putting up a supplementary station of 200 h.p. all the costs must be included.

The 400 h.p. per day from the accumulators will cost :

	f.	£
Interest on capital, 100,000f.	5,000	(200)
Maintenance and depreciation	10,000	(400)
Superintendence and extra staff	6,000	(240)
Total per year	21,000f.	(£840)

While in the case of steam engines we must reckon :

	f.	£
Interest at 5 per cent. on 145,000f.	7,250	(290)
Maintenance and depreciation 10 per cent. on 112,000f.	11,200	(448)
Maintenance of buildings 5 per cent. on 33,000f.	1,650	(66)
Superintendence and extra staff	6,000	(240)
Coal, 6·6lb. per horse-power hour at 20f. (16s.) ton	9,360	(374·4)
Oil, waste, etc.	3,000	(120)
Making practically double . ...Total	38,460f.	(£1,538·4)

(To be continued.)

CITY AND GUILDS OF LONDON CENTRAL INSTITUTION.

Of the candidates, some 100 in number, who presented themselves for the recent matriculation examination at the City and Guilds Central Institution, 64 passed, and 14 did sufficiently well to be admitted as unmatriculated students. In addition to the students who came forward from last session—and these 78, all now attending courses in each of the four departments of the college—some 14 special students have entered for advanced courses, and 59 for the courses in carpentry for elementary teachers. The departments of mechanical and electrical engineering have now their full number of students.

At this entrance examination the Clothworkers' Scholarship of £60 a year and free education for two years was gained by J. R. Dick, B.Sc., Edinburgh University ; the Siemens Memorial Scholarship of £50 a year for three years by F. Macers, St. Dunstan's College, Catford ; the Mitchell Scholarship of £30 a year and free education for two years by E. L. Joselin, from the Finsbury Technical College ; and the three Institute's Scholarships, giving free education for three years, were awarded to S. Mendel, Charterhouse School, R. J. C. Woods, educated abroad, and W. H. Everett, Queen's College, Belfast. At the close of the last session the John Samuel Scholarship of £30 and free education, granted to the best second year's student and tenable for his third year, was gained by F. H. Hummel, and the Siemens Medal by G. C. Turner.

Shock from an Electric Light Wire.—In the *Boston Medical and Surgical Journal* a case is recorded illustrating one of the dangers incurred in America in connection with electric lighting. The case is described by Dr. F. W. Jackson, and was that of a young, strong man, aged twenty-two. While driving along a street his horse's feet became entangled in an electric light wire which had broken away from its pole connection. The horse finally extricated himself, removing, however, in the course of doing so, some of the insulating material. It is supposed that the patient, in his attempts to remove the wire, probably seized it at one of the unprotected points, and he was immediately thrown a distance of 10ft. against the kerbstone and back again into the middle of the street. He then swayed backwards and forwards several times, when from some unknown cause the current suddenly broke, and he fell to the ground unconscious. He remained in this state for 10 minutes, when he partially regained consciousness. When he was first seen by Dr. Jackson, about two hours after the accident, his pulse was 100, strong and bounding, temperature 100deg., his pupils were dilated, he was nervous and irritable, and his reflexes are said to have been increased. He also suffered from severe headache. The anterior surfaces of both hands and arms were blackened from the tips of the fingers to a point midway between the wrists and elbows, and were very sensitive to touch. Another curious phenomenon was that the muscles would violently contract on the least irritation—a condition of things which disappeared on the second day. He suffered from severe headache, accompanied by sleeplessness, but after treatment by rest and bromide of potassium for three days he was able to resume his work, apparently none the worse for his curious experience.

THE

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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TO OUR READERS.

Coppered Staples.—*A correspondent would be glad to know where he can buy large coppered staples insulated inside at the bend by means of a piece of fibre which remains in owing to the spring of the staple.*

OKONITE.

The world stands almost in need of another set of interpreters—interpreters of the balance-sheets of public companies—so that some glimmer of the actual state of affairs may be understanded of the multitude. While language may be regarded as the gift of Providence to enable us to hide our thoughts, it is certain that published balance-sheets are usually intended to hide the real state of affairs. We have been especially anxious to see the balance-sheet of the Okonite Company, because our experience of its officials has been anything but satisfactory; some of them seem altogether too big for their places, and have not that *suaviter in modo* necessary to propitiate men with whom they are brought into contact. The balance-sheet, as we expected, is a very faulty document, and notwithstanding the payment of a dividend, does not point to successful enterprise. It may be that the profits shown have been legitimately won: it may be that they are shown by a mere juggling of bookkeeping. At any rate there is no company with so large a capital that ought to go about to get a "loan," or to have such a large amount due to creditors in cash and in bills payable. The cash at bankers and in hand is cash in hand because payment has been deferred, and such deferred payments, as everybody knows, means, in the first place, paying more for goods, and, in the second place, losing all discounts. A little examination of the balance-sheet will show that the company has not a single penny of working capital, and that it is wholly in the hands of its creditors. Let us see.

Capital (preference and ordinary shares)......	£336,590
Debentures..	82,850
Loan	4,785
Total capital	£424,225

That is, the company has £424,225 to spend, and it has spent it all—thus:

Buying the business..................................	£324,990
Expenditure (various)	23,434
,, (plant)................................	82,771
,, (furniture)	1,701
	£432,896

The amount spent in buying the business, however, if we interpret aright, includes £52,291 value of plant at 1st January, 1890, and this should be deducted from the above total, as it also appears in the £82,771. We are told that the value of plant, machinery, stock-in-trade at time of purchase was £107,733, so that if the plant, etc., was worth £52,291, the value of the stock-in-trade at the time of purchase could not exceed £55,442. It is now estimated at £126,901, and if this estimate is too high it can easily be seen where the profit is made.

Going back to capital and outlay, we get a difference in favour of capital (allowing £52,291 appearing twice) of £43,620. The whole of this is used up in adding to stock, and a good deal more besides, for the addition in the time has been £71,459. Another feature not by any means entertaining is that the company owes £58,243—viz. :

Debenture interest	£2,330
Loans	4,785
Creditors	24,196
Bills	26,939
	£58,250

And it has to meet this £56,327—viz.:

Debtors	£41,075
Bills	2,846
Cash	12,407
	£56,327

That is, these balances show £1,923 to the bad, and yet a dividend is going to be paid. No doubt the dividend will be paid not out of funds in hand, but by increasing the indebtedness of the company, unless cash can be obtained by getting rid of some of the stock. Another item will assist to show how this precious balance-sheet has been made out. The income tax is *estimated* at £150. How it can be estimated at that amount when the balance-sheet shows a net profit of £17,754 passes comprehension, and the income tax will be collected on much more than £17,754. No doubt we shall be told that this is a model balance-sheet, and that the fault is not with it but in our lack of intelligence. Perhaps it is, but as yet this is not proven. How many shareholders were induced to invest because of the profit of £21,711, which, no doubt, they thought would be available for dividend? Possibly that £21,711 has also gone into stock-in-trade. Flourishing businesses have an unaccountable way of accumulating stock, but this accumulation is unique. It covereth a multitude of sins. And the best of it is no one can discover them. Okonite has not as yet wended its way into the hearts of English users, and verily it must take heart of grace, and produce something better in the way of balance-sheets before its shares will become a palatable commodity to ordinary investors.

THE POSTMASTER-GENERAL'S REPORT.

The thirty-seventh report of the Postmaster-General has been issued. It consists of the usual statistics, showing moderate progress in telegraphic and telephonic operations, with which only we have to deal. During the course of the year, 239 post offices and 36 railway offices have been opened for telegraphic business, bringing the number of such offices to 5,912 and 1,715 respectively. The revenue from ordinary inland messages has increased by £90,125, from Press messages by £18,520, and from foreign messages by £14,822, making a total increase of £106,799. The average value of the inland message has decreased, being now 7·87d. as against 7·95d. last year. When the interest on capital expenditure is taken into consideration, there is still a deficit of £198,181 in this department. Credit is taken in the report for the successful completion of the telephone line between London and Paris. It is pointed out that great trouble was taken in selecting the land route on this side so as to avoid the necessity of putting wires underground, and we are officially informed "that conversations by telephone can now be most satisfactorily maintained between the two capitals." The rate of telegraphic working is constantly increasing. In 1870 it was by Wheatstone's instruments at the rate of 60 or 70 words a minute; now in practical working it has reached about 400 words a minute, and under experimental conditions has reached 600 words a minute. The total number of telegrams forwarded from the offices in Great Britain reaches the enormous number of 66,409,211, being an increase of 4,005,812 over the number in the previous year. What this grand total would reach to if the great local competition with telephones did not operate, it is difficult to estimate; but of this we may be certain, that the income would suffice to pay interest on capital. The net revenue—that is, the difference between total telegraph revenue and the working expenses charged to the telegraph vote—reaches £150,335, an increase of £4,541 over the net revenue of 1890, which was £145,794. If, however, the total expenditure in relation to telegraphs is taken into account—that is, the total cost of the telegraph service—the balance is altogether on the wrong side. This expenditure is £2,355,719. It should be noticed that the manufacture and issue of the stamps used, the stationery, buildings, auditing, rates, etc., are not charged to the telegraph vote, and these bring up the total cost from £2,266,356 charged to the vote to £2,355,719. In all business concerns it is best to know the exact state of affairs, and we think the national business should show its exact cost and exact returns. As the statistics are at present given this is somewhat difficult.

CORRESPONDENCE.

"One man's word is no man's word
Justice needs that both be heard."

THE PROFESSION OF ELECTRICAL ENGINEERING.

SIR,—The article on "The Profession of Electrical Engineering," by Mr. H. Cuthbert Hall, which appeared in your last issue, is calculated to seriously mislead those who contemplate qualifying themselves for the profession. Though perhaps the *three alternatives* given by Mr. Hall will lead some of your readers to suspect that the experience he has of the subject on which he writes must have been gained in the sister isle, and does not necessarily apply to the rest of the United Kingdom or to the Continent.

The three "alternative" methods of training suggested by the author are (1) a university course followed by an apprenticeship to a firm of electrical engineers, (2) an apprenticeship to a firm of electical engineers only, (3) a one, two, or three years' course at a technical training college.

"Of these three courses, the former is undoubtedly the best," says Mr. Hall, and, while deploring the lowness of the wage, quotes, presumably in support of his conclusions, the case of a gentleman who, after spending £800 on his education at Cambridge, where he came out fifth wrangler, and a further sum of £300 with a firm of engineers, is now in receipt of a salary of £100 per annum as the outcome of his six years' training. Assuming Mr. Hall to be perfectly sincere in the advice he gives, and that he really believes an electrical engineer must devote six years of his life and spend £1,000 for his training in order that an income of £100 a year can be earned, it will probably occur to most people that a single instance such as that given proves absolutely nothing. The only way of arriving at a just estimate of the relative merits of the three methods would be to trace the careers of as large a number as possible of men who have passed through them.

I am able to give some figures in the case of one method which I think may prove useful. These are in connection with the electrical engineering college which formerly carried on its work in Red Lion-square.

The course given extended over two years—the first year was spent in the college, where theory was taught by means of lectures and experimental work in the various laboratories, while the second year was entirely devoted to actual engineering work with the company to which the college was attached. The life of the college was a short one; it ceased with that of the company, which, like so many others, fell a victim to the Act of 1882. It trained, however, a sufficient number of men to show the results to be expected from the course adopted. Of those whose names appeared on the books, 29 per cent. have been lost sight of, but of the remainder, no less than 72 per cent. are still in the profession, some doing well on their own account, others holding responsible posts. I do not, of course, know what incomes these gentlemen enjoy, but most, if not all, certainly get a good deal more than £100 a year.

With much that Mr. Hall says I thoroughly agree, and if space permitted, I could give curious particulars as to the qualifications of a vast number of so-called electricians. Returning, however, to the unfortunate wrangler, Mr. Hall has, as so many people do, simply considered the training and entirely overlooked the characteristics of the man himself.

A fifth wrangler must either be a mathematician of no mean order, or he must possess extraordinary powers of cramming for examinations. At Cambridge the education of such a man, owing to the rich endowments, need not cost him anything; he may, on the contrary, make his education a source of profit. A man like this, who will not, or cannot, look after his own monetary interests, is not likely to be of any service, from a commercial point of view, to the firm which employs him, and the £100 a year must probably be regarded as a charitable gift to a person who has mistaken his calling, rather than as a salary for useful services rendered.—Yours, etc.,

HUGH ERAT HARRISON.

London, W.C., Oct. 12, 1891.

THE REMUNERATION OF YOUNG ELECTRICAL ENGINEERS.

SIR,—Mr. Cuthbert Hall's complaint is an echo of the complaints one has heard from young men just starting in every profession, as far back as one can remember.

The young parson, after quite as expensive an education, and with often quite as good abilities, finds himself, at the age of 23 or so, privileged to wear the glossiest of black coats and the whitest of ties on the magnificent income of perhaps £80 per annum, and with the additional calls upon his purse entailed by visiting the poor.

The young schoolmaster is the same, the young naval and the young military officer also. Nor have the juniors of any of these professions any extraordinary incomes to look forward to in the immediate future. The curate perhaps serves a vicar who administers to the spiritual wants of a large parish and to the temporal wants of a large family on the magnificent income of, say, £250 per annum, with perhaps an Easter gift and a few presents thrown in, and without the smallest prospect of ever being anything else but vicar of the same parish on precisely the same income. The schoolmaster sees men who have been schoolmasters for a score of years getting incomes of £150 or £200. The naval officer sees many of his brother officers that are old enough to be his father getting incomes of from £200 to £300, and that only on condition that they keep two homes, spend several consecutive years away from their families, and exist during the time they are at home on about one-third of the amount.

There are prizes, of course, in all these professions—archbishoprics, headmasterships, admirals of the fleet, and so on—but everyone cannot have them.

At present there are few such large prizes in electrical engineering, because it is a new branch, but there are still plenty for those who can get them. As a matter of fact, however, it may be taken that £300 a year is a good average income in these times for a highly-educated man in almost any of the professions, and that any youngster, no matter what his parents may have spent on his education, must be content to begin at something very small—usually less than the figure Mr. Hall's friend receives—and work his way up gradually, as opportunity offers. In electrical engineering there will be plenty of good prizes for men of skill and perseverance as time goes on.

But it may be asked, is it any use to educate a lad? Why not let him go as apprentice at 13 or 14 years, and work on that way. The answer is, the education given to a lad in his youth, provided he makes a proper use of it in after years, determines the position he will be able to take, should the opportunity offer, as a man. In these days, under no conceivable circumstances can an uneducated man attain to a leading position in any branch of engineering. The case is very much like many that are met with in manufacturing. A particular kind of clay, for instance, that is used for high-class pottery may be used for inferior work, or a particular piece may be spoilt in the course of manufacture, but under no circumstances could an inferior clay have been made into the higher-class work.

So, too, a particular ingot of steel may be rolled into rails worth a few pounds per ton, or it may be drawn out into watch springs worth over £1,000, but inferior steel could not be made into the latter.

This, then, is the sole end of the education a youth receives—viz., to fit him, or, rather, to enable him to fit himself, for the higher positions he *may* occupy later in life if circumstances are favourable. This being so, however, is it not wiser to limit the amount spent on education to the probabilities of the future position that the youth may hope to attain. If a working-man could afford the expense, it would surely be unwise for him to send his son to Cambridge, or even to keep him at school during the years that might be more profitably employed in learning his trade.

And this brings one to the question: Is it wise, under ordinary circumstances—such, for instance, as those detailed by Mr. Hall—to incur the expense, and to spend the time necessary to take a degree at Cambridge?

The answer to this must be dictated by the particular conditions of each case. If a young fellow's parents or friends can launch him at a higher level than others have to take; or can look forward to giving him the necessary opportunities that will enable him to reach the highly-paid places without the struggles that others have to make; or if there be particular conditions which render it probable that he will be able to place himself on this higher plane, then the money and time will be well spent. But in the vast majority of cases, parents will not only not be conferring a benefit on their sons by giving them a Cambridge education, they will be doing them a positive injury.

The three years spent at college, however well employed, will not do them one-tenth part of the good for their future work that the same time properly employed in practical work would have done. Living, as articled pupils in electrical engineering works do, in an atmosphere of electricity, they will have very little trouble in acquiring a sound knowledge of theory by reading up in their evenings, if they will. And their knowledge is all the sounder for being constantly subject to the check of practical experience. After a man has left college, too, he is usually too old to teach in the same way as he could have been taught at 17 or 18. Often he thinks he knows more than those placed over him, often he has much to unlearn. His college life also, continued as it is right up to early manhood, tends to unfit him for the rough work in which the best experience is obtained. And when he emerges from his articles at twenty-three or twenty-four years of age, for the greatest part of the work that he may be called upon to do, he is of no greater value than the young man who was articled at 18, although he may be a Cambridge wrangler. His Cambridge education will help him to calculate to a nicety the resistance of the magnetic circuit of a dynamo, but it will be very little help to him, without practical experience added, when the dynamo perversely refuses to give a current, or a telephone refuses to speak.

But it may be asked, is there any advantage to be gained by adopting the profession of an engineer, as against other professions? The answer is, Yes; there are more opportunities to be taken advantage of than in other professions. A curate may preach like an angel, yet, unless he has a relative or friend, or influence, a curate he will remain all his life.

An engineer, however, and particularly an electrical engineer has many ways of making opportunities of showing his knowledge and skill, and of forcing his way to the front by what our American cousins call "sheer grit." That is the great advantage apart, from the fascination of the work, of belonging to some branch of engineering.

Before concluding, it would be as well to point out that very few fortunes, if any, have been made in electrical engineering pure and simple. The fortunes that have been made have been due in nearly every case to lucky strokes of finance, not to engineering, and it is in part due to some of those fortunes that salaries are low, and dividends non-existent. The business of an electrical engineer is a very expensive one to carry on, principally on account of the very rapid advances that are being made, and the absolute necessity of keeping abreast of them. Also, it is an error, as commercial men well know, to suppose that neither ability nor education are necessary for responsible positions in the commercial world. It will possibly sound like rank heresy to proclaim the fact in an engineering paper, but it is nevertheless true that the ability required for responsible positions in commercial life is of a very much higher order than is required for engineering. That this is so is proved by the fact that the highest salaries are paid to, and the largest fortunes are made by, the clear-headed, cool men of business. One word more. As Mr. Cuthbert Hall will know well, the salaries of young or of old engineers are ruled by the same law of supply and demand that governs every other transaction in our daily life.—Yours, etc.,

SYDNEY F. WALKER.

GOVERNMENT TELEGRAPH BUSINESS.[*]

In the course of the year 239 post offices and 36 railway offices were opened for postal telegraph business, making the total numbers of such offices open on March 31 5,912 and 1,715 respectively.

The number of the various classes of telegrams dealt with as compared with the numbers dealt with last year are given in the following table:

Class of telegrams.	Year.	Number.	Increase.	Receipts.	Increase
				£	£
Ordin'ry inland	1890-91	54,116,413	3,303,059	1,774,622	90,125
,, ,,	1889-90	50,813,354	—	1,684,497	—
Press (inland).	1890-91	5,003,409	199,944	113,149	1,852
,, ,,	1889-90	4,803,465	—	111,297	—
Foreign	1890-91	5,480,528	261,908	260,781	14,822
,, ...	1889-90	5,218,620	—	245,959	—
Railway	1890-91	1,535,067	243,279	Nil.	—
,, ...	1889-90	1,291,788	—		
Government ...	1890-91	273,794	Decrease. 2,378		
,, ...	1889-90	276,172	—		
Totals	1890-91	66,409,211	4,005,812	2,148,552	106,799
,, ...	1889-90	62,403,399	4,638,052	2,041,753	—

The average value of the ordinary inland telegrams was 7·87d. as compared with 7·95d. for 1889-90. The increase in the number of inland telegrams is at the rate of 6·5 per cent. as compared with 8·5 per cent. increase in the preceding year, a diminution probably due to no small extent to the increasing use of the telephone both in the metropolis and chief provincial towns as well as between the busy centres. The increase in the number of Press telegrams has been at rather more than the usual rate. The highest rate of increase, 19 per cent., has, as usual, been shown in the telegrams sent by railway companies without payment. These telegrams, which numbered 116,000 in 1871, had increased in 1876 to 243,633, in 1880 to 431,598, in 1885-86 to 734,641, and in 1890-91 reached a total number of 1,535,067. At 8d. each the value of these telegrams would be about £51,000. At 1s. each, which is probably nearer their actual value, the amount would be about £76,500.

The following table gives the revenue and the total cost of the telegraph service, taking into account the interest on capital expenditure, in each of the last seven years:

Year.	Receipts	Expenditure.			Annual interest on capital.	Deficit.
		Charged to telegraph vote.	Charged to votes of other departments.	Total.		
	£	£	£	£	£	£
1884-85	1,784,414	1,731,040	89,724	1,820,764	326,417	362,767
1885-86	1,787,264	1,733,105	99,297	1,832,402	326,417	371,555
1886-87	1,887,159	1,939,764	92,868	2,032,632	326,417	471,890
1887-88	1,992,949	1,928,345	70,688	1,999,033	326,417	332,501
1888-89	2,129,965	1,969,324	72,037	2,041,361	353,787	265,183
1889-90	2,364,699	2,179,921	99,065	2,278,986	299,216 [*]	197,690
1890-91	2,456,754	2,266,356	89,363	2,355,719	299,216	198,181

[*] The annual interest on the capital sum of £10,880,571 raised by the Government for the purchase of telegraphs, amounting to £229,216, is not borne on the Post Office Votes.

Interest has been paid at the rate of 2¾ per cent. instead of 3 per cent. since the 1st April, 1889. The expenses of conversion in 1889 amounted to £27,370.

The chief novelty in the telegraph service has been the construction of a telephone line between London and Paris, which was accomplished last winter in somewhat trying circumstances. The cable between St. Margaret's Bay, near Dover, and Sangatte, near Calais, contains four copper wires of larger size than those generally used for telegraphs.

Much trouble was necessary in selecting the route for the land line in England so as to avoid laying any parts of the line underground, which would have rendered its working very uncertain. This danger has, however, been removed, and I am glad to be able to report that conversations by telephone can now be most satisfactorily maintained between the two capitals.

The line was opened for use on April 1 at a charge of 8s. for a conversation of three minutes.

Some improvements have been effected in the form of Wheatstone automatic receivers in use on fast-speed telegraph circuits. These instruments as improved by the department can now, under experimental conditions, record no less than 600 words a minute transmitted over a single wire, while a speed of about 400 words a minute can be conveniently and safely used in practical working, a very satisfactory result compared with the modest rate of 60 or 70 words a minute which obtained in 1870. By the use of new and ingenious tools specially designed for the construction of telephone switchboards a considerable saving in cost of manufacture has been made, and I am glad to say that all parts of the Hughes instruments in use on the continental circuits can now be made in the Post Office factory, so that the department is no longer dependent on a foreign supply.

On the 16th May, 1890, the seventh International Telegraph Conference assembled in Paris to review the regulations and tariffs agreed upon at the conference at Berlin in 1885. The changes embodied in the convention signed on the 21st June, 1890, took effect on the 1st instant, and their effect will be described in my next annual report.

UNDERGROUND LIGHTING MAINS IN PARIS.[*]

BY E. DIEUDONNÉ.

(Continued from page 347.)

The space underneath the pavement is sometimes already so full that room cannot be found for the conduit, which is of considerable size, even when the number of cables is restricted. In these cases, a species of earthenware drain pipe, Figs. 36 and 36*a*, is used, divided into two parts by a horizontal rebated joint. The insulating supports are laid alternately on the bottom (see Fig. 36*b*).

---

[*] From the Postmaster-General's Report.

[*] From *L'Electricien.*

This kind of arrangement enables up to six cables to be run into the concrete conduits. But a still greater saving of space is sometimes necessary. In certain places, more especially when leading from the stations, the number of the mains becomes so great that bars or strips of copper have had to be used. The stems of the insulators are then grouped along the cast-iron base-plates in the form shown in Figs. 37 and 38. The insulators are constructed of the shape seen in Fig. 39; the same insulators disposed alternately are supported by base-plates of the shape shown Fig. 40.

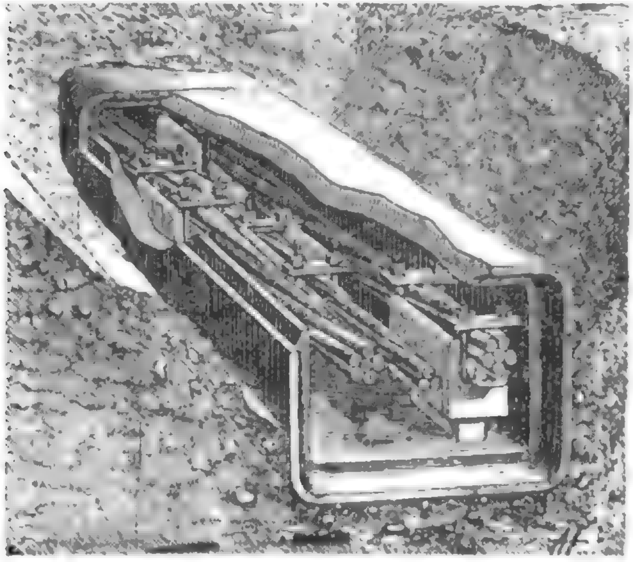
Fig. 36.

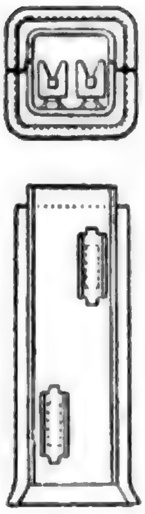
Fig. 36a.

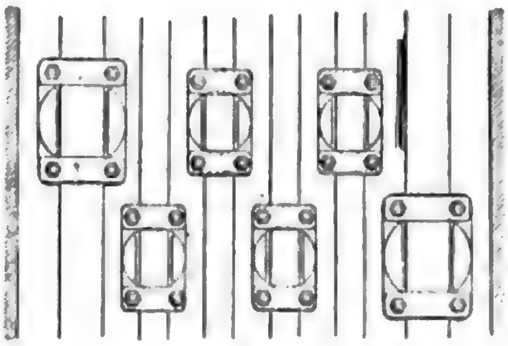
Fig. 36b.

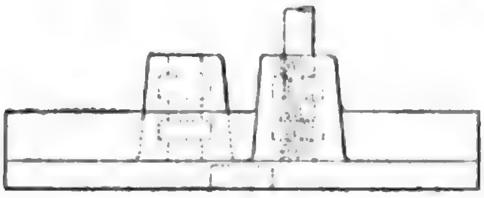
Fig. 37.

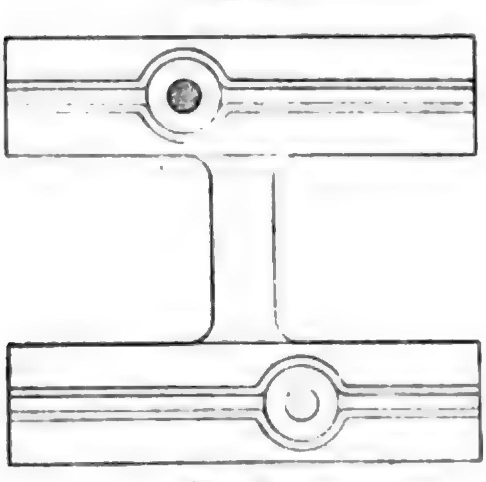
Fig. 38.

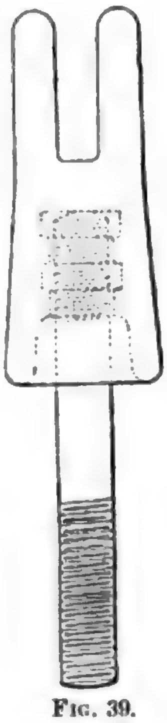
Fig. 39.

In jointing the main cables, the extremities are through at half their thickness for a sufficient length, brought together one upon the other so as to reconst the section of the cable, bound together with copper

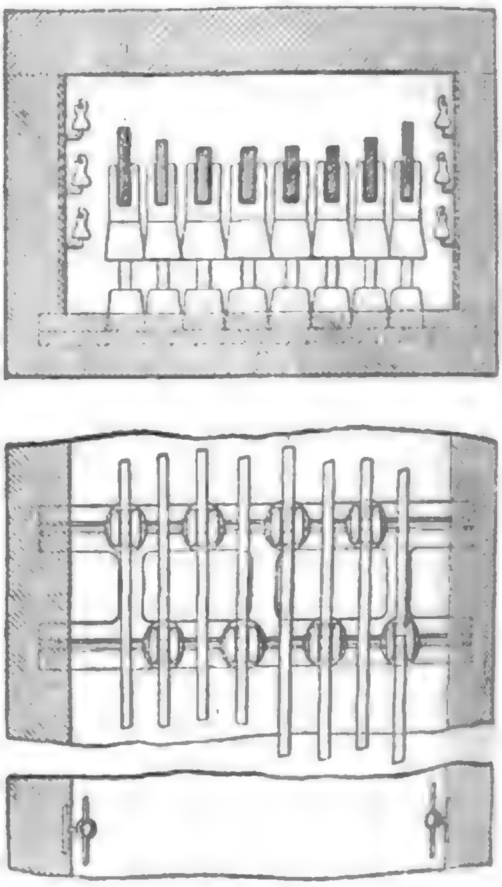
Fig. 40.

then, lastly, screwed together by bolts between the jaws of a split cylindrical clamp and embedded in a mass of solder.

The strips when used are connected together by ir plates, bolted firmly against each other, Fig. 41. Aft the plates are screwed up, melted solder is poured in, forming a perfect contact.

The junctions of strips with cables is made by means of clamps of a special type, of which one end forms a cylindrical space for reception of the cable, and the other end a flat support for the strip. The whole having been firmly bolted together, solder is poured in to fill up the empty spaces (see Figs. 42, 43, and 44).

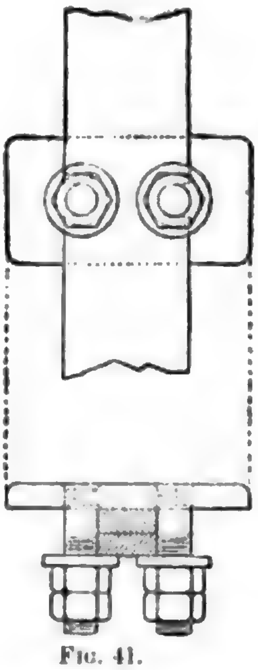
Fig. 41.

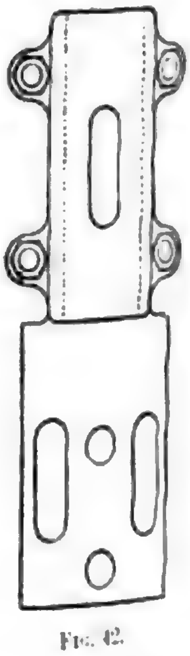
Fig. 42.

The feeders are connected to the distributing mains by a special arrangement, which allows them to be easily separated; at first they were connected up by means of junction-boards, formed by a slab of slate resting upon porcelain insulators. The conductors were screwed up within terminal-pieces having caps fixed by four bolts. Figs. 45 and 46 show a model of one of these tables arranged for three conductors. The current entering by the conductor at the angle might be led to one or other of the terminals, or both might be connected to the angle-piece, the connections being made by means of lead cut-outs.

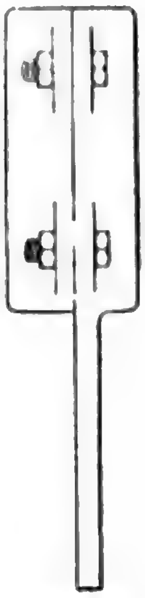
FIG. 43.

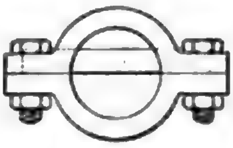
FIG. 44.

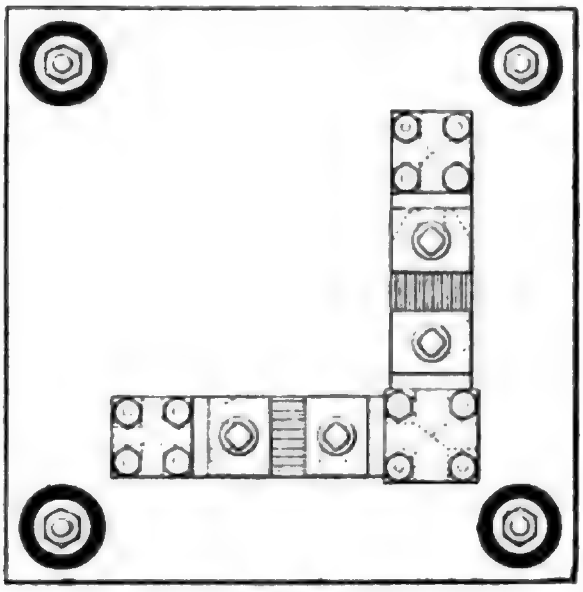
FIG. 45.

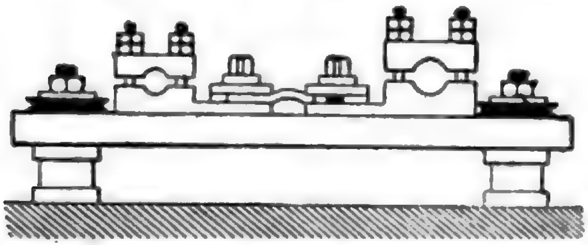
FIG. 46.

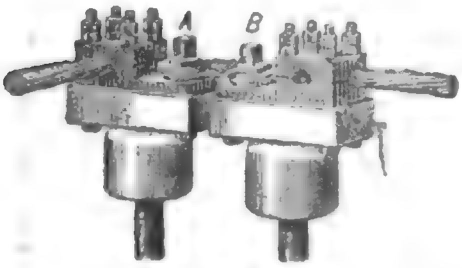

FIG. 47.

This arrangement has not been found as practicable as was expected. In time the insulation of the slate slabs becomes defective. The system has therefore been replaced by that shown in Fig. 47. Bronze connecting-pieces are fastened upon porcelain insulators, whose tops are spread out and flattened into the form of a tablet.

When crossing roadways, the conduits are stopped at vertical pits, down the sides of which the bare cables are led upon insulators, dipping down into an underground arched gallery, in which the arrangements are analogous to those already described. At frequent intervals, and especially when the direction of the conduits change, inspection-boxes are laid about 18in. square, held down by bolts, and asphalted at the top exactly as the pit covers.

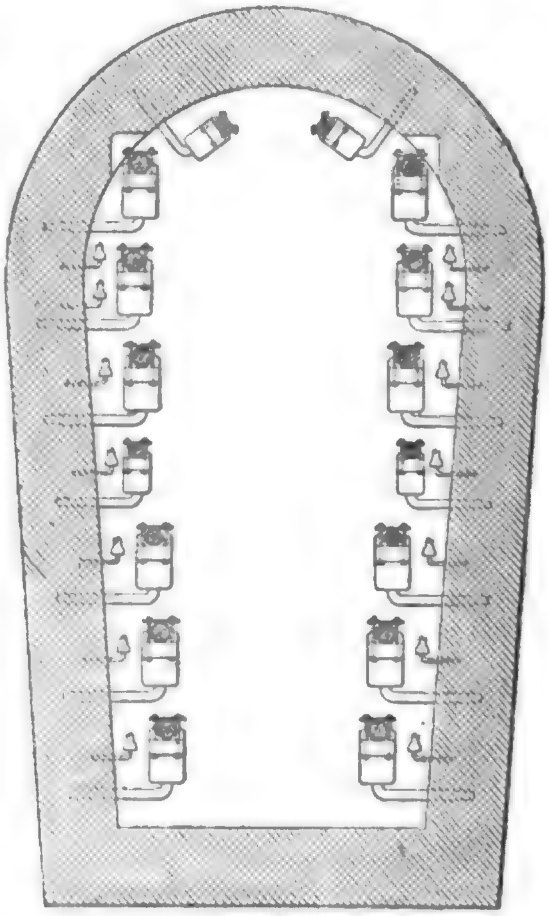
FIG. 48.

Fig. 48 shows in section an underground gallery—the cables ranged along its piers, the positives one side, the negatives the other. The gallery represented contains the whole of the cables coming from the central station of the Rue de Bondy, and going towards the Place de la Republique.

SOME DETAILS OF THE CARE AND MANAGEMENT OF AN ARC LIGHTING SYSTEM AS PRACTISED IN THE MUNICIPAL OF ST. LOUIS.[*]

BY JAMES I. AYER.

(Continued from page 353.)

There are very many details of construction, as well as of office work, which could be referred to if it were not that this paper is now too long, but I will be glad to furnish a copy of "General Instructions to Employés," used in the government of this plant, which refer to and bring out some points of management which are not mentioned here, to those who care for them.

Mr. Ayer remarked that as his paper was printed and in the hands of the members, he would not take the time to read it, but would make some additional remarks. He said:

One point I touch on in the beginning, where I say that I think that our meetings should be largely "experience meetings." I think you will all agree with me in that statement. The practice we have had here of meeting in the morning, carrying our meetings along until we get through the programme laid out, results in this—that if there is much discussion of the papers, or much interest developed in the matters that come before you here, you delay other matters, and carry the work over very close to some entertainment, or into the dinner hour, and this sometimes has been very unfortunate. Yesterday, a paper was read here on electric railroads, by Mr. Field, which was full of interest, and yet because of the lateness of the hour at which it was presented many of the members had gone off to take care of other engagements, or to get ready for the excursion on the river, or to get their lunch, and for that reason the thing was neglected. And yet we had a paper then from a man who was giving us just the character of information we wanted, and which was thoroughly practical in its statements. It concerned a matter which is quite as much of importance to us as the subject of any of our papers, and contained information which we all want to get at. We want the central station men to say something. We want to have papers emanating from them which are pertinent to their business. That thought has been suggested to me, and I presume is in the mind of everyone who comes here for information.

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[*] Paper read before the Convention of the National Electr Light Association.

In referring to our station, and in giving you this paper, I have done so with the idea of bringing out, developing, and inviting other papers of this nature. I want to say with reference to this station of ours that the problem which I had there was different from that of almost any central station that I know of to-day. It was to start in and build a plant of large capacity—to spend money far in excess of the requirements of the station by the business in sight, and to build a station which still had a very large business to start with. We already had a contract with the city of St. Louis for 2,000 lights, and the prospect was when the station was first laid out that it would ultimately absorb other companies, take in a number of smaller stations, as was afterward done; and so my instructions were to build as large a station, on a given piece of ground, which they handed over to me, as I could and regardless of what it cost. I was confronted by a problem in that particular which will explain some of the peculiarities of construction which we adopted. I built a station with a working capacity of 6,000 lights, but when the station was put into operation it commenced with 2,000 lamps. All the stations throughout the country which are in the hands of our members have, as a rule, grown up from small affairs. They started up in some junkshop or other with a few dynamos, and grew as the necessities required, and the result is that there has been an enormous amount of patchwork all the way through. But in our station there is nothing of the kind. We had to start off and build something which would be complete in itself, and which was comprehensive enough to take all the work in the near future that was likely to be drawn into it. Since putting the station in operation we have absorbed the other companies, and brought up the output of the station to the number of lights mentioned in the paper. At the time of building this station there was nothing of its character, size, or magnitude in this country. The problem which confronted me, aside from the designing and construction of the station, was the system of management to be adopted, the methods to be applied, the details relative to the management of the men, and it all had to be worked out and put in motion with the wheels at the beginning. The plan that I outlined, the blanks that I made for the government of my men, are the ones that I am using to-day. I have made but few minor changes in the original blanks that were laid out before we had done any work at all in the way of operating. And while undoubtedly we have followed in detail many of the practices that have obtained in other central stations in the management of our men and in the division of the work, I want to say that I was unable, on applying to a number of cities, to get anything to assist me in arranging our blanks or system. It was a thing that could not be found. I have since found, in conversation with central station men who have large plants, that we have thought out the same ways independently, of managing our stations independently—that we are working on similar lines. In some instances it is peculiar that it is so. One object of the paper in outlining the details of practice at our station is because of the fact that that has not been done very much, and because I realised what difficulty I had in endeavouring to obtain information. In fact, I did not obtain any that was of value to me. That is my excuse in a measure for going into details of our plan of working to such an extent in this paper.

First, I will refer to our method of caring for the street lamps. We have got a number of street lamps distributed over a very large area. The city required that our lamps should be supported very high above the street. The minimum altitude of the lamps is 35ft. above the roadway. The city also required that we should suspend them between the poles. They were arbitrary in the matter. In order to get our lamps at that elevation the shortest pole that we could use was 50ft. in length. In suburban lighting they require the lamps to be 50ft. above the roadway, and they have to be suspended from 65ft. to 70ft. poles, according to the length of the span. The average distance apart is about 900ft. I think that we have about 1,500 lamps where the average distance apart is 825ft. The balance of them, 500 or more, have an average distance of 1,300ft. between the lamps. These are long distances. In lighting the suburbs and, in fact, the whole city, we have found the use of a cart and horse very desirable.

(*To be continued.*)

ELECTRICAL POWER FOR THE GLASGOW CORPORATION TRAMWAYS.

REPORT BY DEPUTATION TO FRANKFORT.

For some time past the question of adopting mechanical haulage for the Glasgow Corporation tramways (which have hitherto been leased and worked by a public company) has engaged the anxious attention of the Town Council Committee on Tramways, and latterly there have been some negotiations, with that object in view, with the directors of the General Electrical Power and Traction Company, Limited.

In the course of last month it was announced to the subcommittee on the future working of the tramways that the directors would be glad to receive and have a conference with a deputation of their number in London, and there was forthwith adopted a general memorandum of the points on which the sub-committee desired to obtain information from the company, which was duly forwarded to them. Subsequently it was resolved that the deputation should consist of Bailie Paton (convener of the Tramways Committee) and Councillors Colquhoun and Wallace, with Mr. David Rankine, C.E., the engineer who has laid out the whole of the Glasgow tramway system, which is now probably the most extensive in the kingdom owned by one public body.

At the last meeting of the Town Council the deputation submitted an interim report on the subject on which they were instructed to obtain information. Here follows the report, the interest of which is so great that other corporations may profitably give heed to the details and suggestions mentioned in it by the keen observers and hard-headed Scotsmen who formed the deputation :

"The deputation beg to report that, according to arrangement, they met in London on 22nd September with the directors of the Electric Power and Traction Company, Limited, with whom were representatives of the Electrical Power Storage Company. The immediate object of the meeting was the interchange of views relative to the introduction of cars worked by electric motors on the Glasgow tramways, and the obtaining of guarantees from the company as to the rate per car mile run at which they would maintain cars worked by storage batteries. The questions emerging therefrom could only have been elicited at such an interview, and they were discussed in considerable detail. The result was the formulating of conditions under which the company is to submit an offer for maintaining the accumulators on a number of cars on that system. It was anticipated that the information supplied relative to the lines of tramway would have enabled the company to frame their offer and have it lodged with the committee before this time ; but within the last few days a letter has been received stating that the engineer to the Electrical Power Storage Company cannot satisfactorily settle the accumulator system without having profiles of the proposed tramway routes. These are being prepared, and will be duly forwarded. It may, however, be meanwhile stated that the figures indicated as those which would probably be contained in the offer to be submitted would show a material economy and saving when compared with animal traction.

"When in London the deputation embraced an opportunity of witnessing a further development of electric haulage on the accumulator system, as worked out by the Ward Electrical Car Company, Limited, and applied to the traction of street omnibuses. The deputation were conveyed in an omnibus so worked across Westminster Bridge and through several crowded streets. They were much pleased with the run, and gratified to witness the ease with which the omnibus could be turned and worked in with the general traffic. This company has not yet entered upon tramway working, but their system is equally capable of being applied to tramways, and their manager said they would be prepared to maintain accumulators under suitable guarantees; but it was thought unnecessary to trouble them in the meantime to make up estimates until the negotiations with the Electrical Power and Traction Company had been further advanced.

"The deputation also examined the developments now being proceeded with by the London Tramways Company, in the adaptation of the tramways at Brixton to cable haulage, and the maintenance of the tramway traffic on a single line by crossovers, while the tramways are being so adapted in a precisely similar way to what was done while the tramways in our own city were being renewed. The work was, however, especially interesting as showing the views of the tramway company in their being at considerable expense of altering an existing tramway worked by horses, on a roadway practically level, to a tramway to be worked by cable haulage.

"The deputation next proceeded to Frankfort-on-Main, where an electrical exhibition is being held. This exhibition contains a large variety of plant for the manufacture, distribution, and utilisation of electrical power as applied to lighting and to motor purposes, and these are exhibited in actual working.

"A tramway worked by electrical power on the overhead wire system is an adjunct of the exhibition, and there are practical examples of mining operations, underground haulage, and other appliances, thus illustrating the numerous uses to which electrical energy is now applied.

"In the city of Frankfort-on-Main and its suburbs two tramways worked by electrical power are in operation on the streets for the ordinary purposes of street tramway traffic. Including the tramway within the exhibition, we thus witnessed three modes of electric traction, all on the overhead wire system. The power is conveyed from the overhead wire to the car motor by a different mode in each case—the first by the fishing-rod attachment, the second by the slider and wire, and the third by the sliding bar.

"There can be no doubt that the overhead wire is the simplest form for communicating tramway traction, and possibly it is also the cheapest in construction, working, and maintenance.

"On the Frankfort and Offenbach tramway, which is a single line about four miles in length, with passing places, an efficient service of cars is maintained on a roadway in many places narrow, with quick turnings, at low fares (the through fare being rather less than 2½d.), the distance, including stoppages, being run in half an hour. The slider and wire attachment is that which is in use here. It permits of the overhead wires being carried and deviated to either side of the tramway, as circumstances may require; but it is rather more unsightly and objectionable to the amenity of a street than the sliding-bar arrangement.

"The sliding-bar attachment is worked on a length of about three-fourths of a mile of street tramway. It enables turnings to be made on the line with a smaller number of supports than the fishing-rod system, as the bar operates equally successfully, although the overhead wire may diverge somewhat from the centre line of the tramway.

"The whole of these overhead modes are open to the objection that the cars are unadapted to the carrying of outside passengers. That, therefore, implies a greater dead weight per passenger, and would much detract from the popularity of a service in our city, where a considerable percentage of the passengers prefer to ride on the top of a car when the weather permits.

"A vivid spark is emitted when the slide bar passes the connection of the overhead wires with their supports, and although that may possibly not be of much moment where the car service is comparatively infrequent and the ordinary vehicular traffic not large, it is open to objection in busy streets.

"We would naturally look for the objections to an overhead wire being overcome by an electric cable in a conduit under the line of tramway. The deputation have not seen this system in operation. They understand it is in use at Blackpool. A writer states that in some cities in the United States where the conduit system had been tried it had been abandoned. The reason for this appears to have been the difficulty of obtaining perfect drainage, which is an essential requisite for that system. On the other hand underground conductors supplied from central stations have been in operation at Budapest since July, 1889, when a line 1½ miles long was opened; a second line, 2¼ miles long, being opened in September of that year; and a third in March, 1890. Since then further lines have been constructed. Nearly 5,000,000 passengers were carried by the three lines up to the end of 1890.

"A sub-committee formerly reported on the working of cars on the accumulator or storage-battery system, which is in practical operation on a section of the Birmingham tramway, and at Barking, London. That system possesses the merit of being capable of being applied to existing tramways without alteration of the lines, provided they are substantial enough to carry the additional weight imposed by the accumulators and relative build of car. Each car is also an independent motor, and is thus free from the objection, which is urged as likely, occasionally, to be experienced of a stoppage over the whole system of tramway, arising from any accident or breakdown of machinery when the power is transmitted from a central station, whether in the form of electrical or cable power. The objections to the accumulator system are the weight of the cars and the expense of maintaining the accumulators. This question will, however, be solved by the offer which is to be received from the Electrical Power and Traction Company.

"The cable form of traction was also reported upon. There can be no doubt that this is one of the best forms of traction by which steep grades can be successfully overcome; but the deputation further believe that on comparatively level roads where there is considerable traffic, it forms a less costly mode of traction than animal power, notwithstanding the greater cost of the road bed.

"The general conclusions the deputation have arrived at to the present time are—

"First, that mechanical haulage, either in the form of electrical or cable power, offers advantages to the public which cannot be given by cars worked by animal power.

"Second, that the expiry of the current lease is a fitting time for the introduction of mechanical haulage on one or more sections of the tramways, with the object of its general and gradual adoption; and

"Third, that, with the view of further enquiry, the sub-committee should be further continued.

"WALTER PATON, H. WALLACE,
"JAS. COLQUHOUN, DAVID RANKINE, C.E.

"Glasgow, 5th October, 1891."

LONDON COUNTY COUNCIL.

The following portions of the report of the Offices Committee, presented at the last meeting of the Council, relate to electrical work:

The Council has from time to time given authority for the installation of the electric light in some of the rooms of the main building. We have now to report that we have had under consideration the desirability of extending the light throughout the whole of the offices. We have had a report from the Council's medical officer of health on the injurious effects of gas, and the advantage that would be derived by the adoption of the electric light. He states that the amount of air required to dilute the carbonic acid resulting from an ordinary gas burner is more than double the amount of air required to dilute the carbonic acid given off by a human adult. The necessary cubic space required for purposes of health in any room is therefore vastly greater when gas is used. In the opinion of the medical officer, the use of the electric light is attended with no disadvantage connected with health. The medical officer of the Post Office, in writing to him on the results attending the use of the electric light in that department, gives a very favourable opinion. He states that "the fact that a much better light is given without the evils attendant on the use of coal-gas—namely, the abstraction of oxygen, the production of the results of its combustion, and also, no mean consideration, the generation of great heat—must commend its use to everyone." He further states "that the officials in the Post Office have expressed themselves to be feeling much better in health, and better able to perform their duties since the adoption of the electric light." The Council's medical officer also informs us that Mr. Brudenell Carter has had exceptional opportunity for studying the effect of electric lighting on the eyes, through having under his observation all cases of impairment or defect of sight among the persons employed in the offices of a large London industrial establishment. After several years' experience of the electric light in this establishment, Mr. Carter states that no prejudicial results have attended its use. The chief engineer estimates the cost of the work at £1,500, and in his report adds that, as there is nothing in the light to blacken ceilings and walls, the adoption of the electric light would lead to a saving in the present somewhat heavy expenditure for annual cleaning. There is also far less danger from fire if the work is well done and properly looked after. The offices, as the Council is aware, are crowded, and in view of the medical officer's report, we are of opinion that the evil effects likely to be caused to health by this crowding might in a measure be remedied by the adoption of the electric light. We accordingly recommend:

> That, subject to an estimate being submitted to the Council by the Finance Committee as required by the statute, the electric light be extended throughout the main building of the offices of the Council; and that we be authorised to obtain tenders for the work.

The chief engineer has pointed out that it would be convenient if the premises, No. 31, Spring-gardens, where a portion of his staff is located, were placed in telephonic communication with the main building. The cost would be about £10 per annum. We recommend:

> That authority be given for the premises, No. 31, Spring-gardens, to be placed in telephonic communication with the main building, at a rent not exceeding £10 a year, and that the solicitor be instructed to prepare a three years' agreement with the National Telephone Company for the purpose.

The committee recommend that the following expenditure be authorised: For electric lamps, £15. 10s.

The Sanitary Committee reported that, acting on the authority of the Council of the 28th July, No. 19, they had accepted the tender of Messrs. Drake and Gorham for the provision of electric lighting at the Newington permanent weights and measures office. The tenders received for this work were as follows:

Messrs. Drake and Gorham	£143	0	0
Brush Electrical Engineering Company.........	150	0	0
Messrs. Crompton	182	17	10

LEGAL INTELLIGENCE.

HIGGINS v. THE LONDON ELECTRIC SUPPLY COMPANY.

Claim for Wages.

In the Westminster County Court on Wednesday, the case of Higgins v. The London Electric Supply Company came on for hearing before his Honour Judge Bayley, and was an action by the plaintiff to recover £6. 18s. 8d., wages alleged to be due under somewhat peculiar circumstances.

The learned counsel, in opening the plaintiff's case, said his client had for some time past been in the service of the defendant company, and had been engaged in the dangerous occupation of laying electric mains underneath the streets of London. On 9th May last he was engaged in laying some mains in Burlington-street, Regent-street, when, owing to the fusing of the wires, he was very seriously burned about the shoulders. On the following day he went and told the firm what had happened, and they told him that they would pay him his wages as long as the doctor certified that he was unable to work, especially, so he alleged, if he was quiet and kept the matter a secret.

The **Plaintiff** was called and gave evidence as to the nature of the injuries and to the defendants' promises to pay his wages, which they did up to July 18th, on which day he called as usual for his money. He was then asked if he could come to work, and he told the engineer that he was able to He was then directed to write to Major Waller, which he did, but never received any reply from that gentleman. Cross-examined: He had only been in the employ of the company since March 3rd, and was engaged as a "lineman" at 8d. per hour.

Dr. Kay was called and said he had attended the plaintiff for his injuries since the middle of May. He was suffering from very serious burns about the shoulder. He (witness) was told that the company would pay his bill, and upon that assurance he returned the plaintiff what he had already received of him. The plaintiff was still suffering from the injuries, but was able to do light work.

For the defence, **Mr. Gerald Wm. Partridge** was called, and said he was engineer to the company, and he it was who engaged the plaintiff at the rate of 8d. an hour. He was not present when the plaintiff met with the accident, but saw him from time to time. Various sums of money were paid to him from time to time, but merely as gratuity, and not as wages. Men in the plaintiff's position were not engaged as weekly servants, but by the hour, and they were liable to an hour's notice.

Mr. R. S. Payne, accountant to the company, was also called to give evidence as to the circumstances of the case. It was the custom of the company in cases of accident to always behave well to an injured man, and they had done so in this case as long as the necessities of the case demanded it.

Having heard all the evidence, the learned **Judge** said the plaintiff was nothing but an hourly servant, and the company had behaved very handsomely to him. Judgment would therefore be for the company, with costs.

COMPANIES' MEETINGS.

CITY OF LONDON ELECTRIC LIGHTING COMPANY.

The first ordinary general (being the statutory) meeting of this Company was held at Winchester House yesterday (Thursday) afternoon, the chairman, Sir David Salomons, presiding.

The **Chairman** said there was no business to be done at the meeting, but they might like to hear a little of what was going on. He then sketched the history of the Company, and its connection with the Pioneer Company, as well as that of the partitioning of the City between the Brush Company and Laing, Wharton, and Down up to the present time. Speaking of the applications for lights, he deprecated the idea that directly after the application was sent in the lights could be supplied. They only really began business on 21st of last August, and as it was their intention to do everything throughout in the best possible manner, so that it would not have to be done again, those who sent in applications must give them time to carry out the work properly. The total equipment provided for private lighting would be for 400,000 8 c.p. glow lamps, and was based on the supposition, a safe one, that 80 per cent. would be alight at one time. Laying underground mains in the City was very difficult, the whole of the space below ground being occupied by iron pipes of some form or another. The expense, therefore, would be heavier than in the West-end. The system to be employed was a very safe one, and there would be no transformers. There were to be sub-stations supplying eight to 10,000 lamps, and between these and the head station a high-pressure current would be delivered at about 2,000 volts. This pressure was dangerous to life, but had been tried on a large scale and over an extended period in London and other towns, and had always met with success. The voltage between the sub-stations and the houses would be a trifle over 100. No one therefore need expect on turning a switch to receive a shock, as with transformers might occur This would give confidence to customers. The arc lighting would be on the continuous-current system. Part of the districts would be lighted by Brush and part by Thomson-Houston lamps They had 26 Brush arcs at work in Queen Victoria street already, but the lampposts had not been passed by the city engineer, and until they were they could not proceed with that work. They had already had as many as 200 applications, or thereabouts, for light, and assuming 200 lamps to every building, about 40,000 lamps had already been applied for. The applicants had not stated the number required yet, but forms would shortly be got ready on which the requirements of applicants could be stated. Among those applying had been the Post Office, the Mansion House, Guildhall, banks, offices, and so on. From this it would be seen that the large public concerns put faith in them. It was expected that private lighting on a small scale would probably be started by the end of the year. About three fourths of the capital they wanted was subscribed for, the remaining one-fourth would be issued, and the Board were considering whether they should not offer this to the shareholders at a small premium. In the prospectus a certain sum was reserved on the part of the Pioneer Company to pay the expenses of floating this Company. In consequence of the whole of the capital not having been allotted, and in consequence of other economics, there would be an extra sum of £6,000 placed to their credit. So that although they had not got the whole of their capital, they had saved this sum. At their Board meeting that day they had given the final order for the wiring of all the chief districts in the City, taking in the Bank of England and a good part of Queen Victoria-street, and other streets close by. They hoped by the end of the year these districts would be completed as well as the greater part of the public lighting, which would bring them in a very considerable revenue. He would answer a question very frequently asked, and that was, what did a glow lamp cost per hour? At 8d. per unit, which was about the price charged by other lighting companies, and which would be about the price he expected they would charge, an 8-c.p. lamp cost as nearly as possible one farthing per hour, which compared with gas at about 5s. or 4s. 6d. He then pointed out the many economies of electric lighting over gas which entered into calculations of cost per lamp. They had appointed Prof. Silvanus Thompson their consulting electrician Having invited and answered several questions of no great importance, the Chairman asked some shareholder to propose a resolution that had been drawn up, the object of which was to alter one of the articles of association so as to comply with the requirements of the Stock Exchange, and so enable them to obtain a quotation for their shares.

This resolution was proposed by **Mr. W. Bruce**, seconded by **Mr. John Morris**, and carried unanimously.

The proceedings then concluded.

ELECTRIC ARMS AND AMMUNITION SYNDICATE, LIMITED.

The first ordinary general meeting of this Syndicate was held at Winchester House on Friday, 9th inst. **Major Waller** presided, and, in moving the adoption of the report, observed that they met in rather exceptional circumstances, a petition having been presented by five of their shareholders to the Court for the compulsory winding up of the Syndicate. The Board had opposed the petition in the interests of the shareholders generally, feeling that there should be no liquidation until, at any rate, the general body of them had had an opportunity of expressing their views on such a course. With the exception of two or three shareholders outside of those who had presented the petition, the Directors were supported by the whole body. The first hearing of the petition was on the 30th ult., when the judge ordered it to stand over until after that meeting, so that he might hear at the adjournment what might be the feeling of the shareholders. The Chairman then referred to the trial at the annual meeting of the National Rifle Association at Bisley of the Syndicate's system of electrical discharge. He regretted that they had not been able, as they had intended, to use the service weapon, the Martini-Henry rifle, at the competition organised by them at Bisley, owing to the non-arrival from America of a machine which the American Company had undertaken to supply them with. Experiments had shown that there was a defect in the mechanical construction of the battery cases, but not in the principle of the battery. A new battery had been produced, which appeared likely to answer fully the requirements of the Syndicate's system. Dr. Fleming had examined this battery with scrupulous care, and had put it under the most severe tests. Last May their then manager, Mr. J. R. Watson, announced to the Board his desire to resign, and when asked for his reason expressed doubt about the Syndicate's system. That gentleman was one of the petitioners for winding up the Company. He then read a letter, dated the 8th inst., which he had received from Dr. Fleming, who stated that he was continuing to test samples of the battery, and that, although the inventor had yet to overcome some difficulties in the construction of the battery, he was on the way towards a satisfactory solution of them. The question really at issue was the permanence of the battery, and hence these tests must necessarily take some months. They proposed to call the shareholders together again in about three months' time, and not to make any other call without consulting the shareholders first.

Colonel Ernest Villiers seconded the motion, which, at the suggestion of **Mr. E. M. Underdown, Q.C.**, was altered as follows: "That the report and accounts be received and adopted, and the business of the Syndicate be continued."

Mr. Watson, sen., expressed doubts as to the feasibility of the Syndicate's system of electrical discharge, having heard that at the meeting at Bisley there were very numerous miss-fires. Captain Pixley, on the other hand, stated that he had fired several shots at Bisley, and had not had a single miss-fire.

Mr. Pooley read a letter which he had received from a firm of gunmakers, who, he said, expressed their opinion that the invention could only be used for toy purposes. He moved an amendment, in effect rejecting the report and accounts, and confirming the course taken in presenting the petition.

This was lost The original motion was declared carried by six votes to four.

Major Waller was subsequently re-elected to his seat at the Board.

INTERNATIONAL OKONITE COMPANY.

DIRECTORS.—Lord Greville, chairman; Samuel Pope, Esq. Q.C., vice-chairman; Sir Alexander Armstrong, K.C.B., F.R.S., Harry Hankey Dobree, Esq., Major Charles Jones, R.A., John Henry Tod, Esq. Directors acting as a local committee and managers in New York: John H. Cheever, Esq., W. L. Candee, Esq., H. Durant Cheever, Esq., E. Cazenove Jones, Esq., John L. Martin, Esq. Managing Director: Alfred Vaughan-Stevens. Managers at Manchester Works: John Shaw, Thomas Connolly.

FIRST ANNUAL REPORT.

The Directors submit to the shareholders the accounts of the Company made up from the 1st January, 1890, to the 30th June, 1891, a period of 18 months; the American accounts are, however, made up to the 31st May, 1891, and therefore cover a period of 17 months only. After deducting ample depreciation and making provision for the interest on debentures, there is a credit balance of £39,465. 7s. 2d. This includes the profit earned from the 1st January, 1890, to the date of the registration of the Company—viz., £21,711. 1s.—which sum, not being available for distribution, the Directors have written off patent and goodwill account. Up to the end of the year 1890 the business was progressive and satisfactory, and the interim dividend then declared was justified by the business done. Since that time the Company has suffered from the results of the severe crisis which took place in the United States in all electrical, engineering, and kindred industries, and which culminated in the failure of the Westinghouse Company. In addition, through the operations of speculators during the latter part of 1890, rubber, which is one of the principal raw products used by the Company, was maintained at an abnormally high price, whereby the profits have been seriously affected. Copper also stood at an advanced price. The interim dividend paid in January on the preference and ordinary shares has absorbed £10,694. 19s., leaving a balance of £7,059. 7s. 2d. to be now dealt with. The Directors recommend the payment of a further dividend of 4 per cent on the paid-up preference share capital for the half-year ending June 30, 1891, making 8 per cent. for the year. This will amount to £6,800, leaving a sum of £259. 7s. 2d., which it is proposed to apply to reduction of preliminary expenses. The Directors are pleased to state that there has been a marked revival in the electrical trades since the period covered by the accounts, from which revival the business has already benefited. The sales have been larger in the months of July and August than in any of the preceding months of the present year, and it is confidently anticipated that the Company will benefit from the general improvement of American industries. Moreover, since the failure of the speculation before referred to, indiarubber has fallen to its ordinary price, while copper also is lower. The Directors, therefore, have every confidence in the immediate prospects of the Company. They are thoroughly satisfied with the progress made in England, and now that the new works are complete they anticipate a considerable increase of business in the immediate future. It has been considered desirable that the Company should be in a position to carry out in its own works every process connected with the manufacture of all kinds of insulated wire. The Directors have therefore erected additional buildings and machinery at the Passaic works, which are now complete in every particular. This has necessitated a larger capital expenditure than was originally contemplated, but results have shown that the Company will in the future derive great benefit from these extensions. In England the growth of the business has justified the Directors in acquiring the freehold of the factory in Manchester, originally held on short lease. The new buildings are now finished, and the factory is one of the largest and most complete of its kind, and is fitted with machinery and plant of the most approved pattern for the manufacture of every class of insulated wire or cable at present in use, including okonite, vulcanised rubber, guttapercha, and compound covered. A well-fitted machine shop has also been provided for the manufacture of the special machinery required for making okonite wire. A sketch of this new factory is enclosed herewith. Okonite insulation has been proved to stand extremes of heat and cold in a very remarkable manner, and to be less liable to perish, either from natural causes or rough usage, than the ordinary forms of rubber-covered conductors. The Directors look forward to its extensive use where high electrical resistance is required, and they consider the present time most favourable for its introduction into this country. It is expected that the manufacture of this speciality of the Company's products will commence at Manchester before the date of the general meeting. The works and plant conveyed to the Company have been maintained in an efficient state. It is the custom in most American works to charge repairs to machinery (including all replacements) to revenue account, and this has been done at the Passaic factory. In Manchester, owing to the entire rearrangement of the processes, nearly the whole of the machinery has been moved, and before re-erection, been thoroughly overhauled and put in high-class condition. To secure uniformity of practice, the cost has also been charged to revenue account. This, although reducing the immediate profits, places the Company in a more stable position, as proper and customary depreciations have, in addition, been allowed for in the accounts. In view of the disappointing results of the trading of the Company, the Directors and Managers in England have decided not to take the percentages of net profit to which they are entitled under the articles of association and their agreements, amounting to £392. 15s. 9d., and they propose that this amount shall be postponed until such times as the net earnings of the Company show a substantial improvement. General Sir William G. Davies K.C.S.I., having resigned, the Directors (in accordance with Clause 95 of the articles of association) elected Mr. John Henry Tod (Tod, Durant, and Co.), 3, Crosby-square, London, E.C., in his place, and they hope this appointment will meet with the approval of the shareholders. The auditors, Messrs. Price, Waterhouse, and Co., retire, and being eligible, offer themselves for re-election, which the Directors recommend.

PROFIT AND LOSS ACCOUNT.—New York to 31st May, 1891, and England to 30th June, 1891.

Dr.				£	s.	d.
London office expenses				1,561	0	9
Directors' and Managing Director's remuneration				2,500	0	0
Legal and professional charges				366	9	5
Advertising				242	3	5
Travelling expenses				130	11	0
Interest on debentures				4,251	9	2
Income tax, estimate				150	0	0
Balance carried to balance-sheet				17,754	6	2
				£26,955	19	11
Cr.	£	s.	d.	£	s.	d.
Profits of American business, from 1st January, 1890, to 31st May, 1891, and of Manchester business from 1st Jan., 1890, to 30th June, 1891, after charging depreciation	47,862	8	10			
Less profits from 1st January to 30th June, 1890, applied towards reduction of purchase of properties and businesses	21,711	1	0			
				26,151	7	10
Interest and discounts				781	9	1
Transfer fees				23	3	0
				£26,955	19	11

BALANCE-SHEET.—New York, 31st May, 1891, and England, 30th June, 1891.

Dr. Liabilities.	£	s.	d.	£	s.	d.
Capital—						
17,000 preference shares of £10 each...	170,000	0	0			
17,000 ordinary shares of £10 each...	170,000	0	0			
	340,000	0	0			
Less calls in arrear	3,410	0	0			
				336,590	0	0
Debentures—						
850 bonds issued of £100 each ...	85,000	0	0			
Less instalment unpaid	2,150	0	0			
				82,850	0	0
Debenture interest due and accrued and outstanding dividend				2,330	9	5
Loans				4,785	3	10
Sundry creditors				24,196	11	1
Bills payable				26,939	6	3
Profit and loss—						
Profit as per account annexed ...	17,754	6	2			
Less interim dividend to 31st December, 1890—viz., preference £5,162. 16s. 5d., and ordinary £5,532. 2s. 7d.	10,694	19	0			
				7,059	7	2
				£484,750	17	9

Cr. Assets.	£	s.	d.	£	s.	d.
Purchase of properties and businesses in America and Manchester, as per agreement of 24th June, 1890	324,990	0	0			
Deduct—Value of plant, machinery, tools, and stock-in-trade included in the purchase £107,733. 8s. 6d., and profits of America and Manchester businesses from 1st January to 30th June, 1890, included in the purchase £21,711. 1s.	129,444	9	6			
	195,545	10	6			
Add expenditure since 1st January, 1890, on new factories in America and Manchester, patents and cottage property in Droylesden-road, Manchester	23,434	3	7			
				218,979	14	1
Plant and machinery, tools, etc.						
At 1st January, 1890	52,291	16	11			
Additions since	30,479	7	10			
	82,771	4	9			
Less depreciation	3,747	8	8			
				79,023	16	1
Office furniture and fixtures	1,701	18	7			
Less depreciation	145	0	6			
				1,556	18	1
Stock-in-trade				126,901	13	8
Sundry debtors				41,075	13	2
Bills receivable				2,845	10	5
Cash at bankers and in hand				12,407	11	0
Preliminary expenses				1,960	1	3
				£484,750	17	9

The ordinary general meeting of this Company was held at Cannon-street Hotel on Wednesday, Mr. Samuel Pope, Q.C., vice-chairman, presiding.

Before proceeding to the business of the meeting Mr. Pope explained that the chairman of the Company, Lord Greville, who was then in Ireland, was unable to be present owing to illness.

The **Secretary**, Mr. R. Cooper, having read the notice convening the meeting,

The **Chairman** asked if the shareholders would take the report and accounts (given above) as read, and there being no dissentient, continued, in moving the adoption of the report,—As deputy-chairman it is my duty to say a few words—I don't think that they need be many, because there is not much to say that has not been already embodied in the report. But I should just like to point out, by way of additional emphasis, one or two of the considerations which have weighed with the Directors in the preparation and presentation of that report. Of course the fact that we are unable to recommend the declaration of a further dividend upon the ordinary shares of the Company is not so satisfactory as one would desire. But you must bear in mind that even with that disadvantage, and in a year of very extraordinary pressure as regards industrial enterprise, the holders of the ordinary stock of the Company will have received 5 per cent. for the years' investment. But let me say that what has weighed with the Directors in the recommendation which is included in the report is, that they regard it as desirable that the management of an industrial enterprise such as this is should be maintained with a view to its permanent stability, rather than with a view to a temporary fall in the value of shares. Of course they are entirely aware that to those who desire to realise their shares, the declaration of a dividend is a very convenient matter; but for those who are investors in the undertaking it appears to the Board to be far better not to declare a dividend in anticipation of future profits, but simply to take the strict and legal course of confining the amount distributed to the amount actually earned, although it may not have the effect of increasing the value of the share to which it is allotted. In other words, I believe the Board are unanimous in the opinion that this undertaking ought to be managed without any dodging of accounts for the purpose of announcing dividends, but that the result of the year's trading should be placed fairly and honestly before the shareholders. Now, if that is in your judgment the true principle upon which an industrial undertaking of this kind should be managed, there is in the accounts and in the report abundant indication of the stability and value of the property of which we are proprietors. Of course, you will bear in mind the special conditions which attach to this first statement of accounts presented to shareholders. It includes, in the first place, as you will remember, the profits purchased by the Company which accrued from January 1 to June, 1890, amounting to £21,711. This amount, not being profit earned by the Company since its registration, cannot legally be distributed among the shareholders as dividend. The Directors therefore recommend that as we cannot divide it it should be used, so to speak, in reduction of purchase-money, so as to reduce the ultimate capital responsibilities of the Company. In the accounts which have been presented, the American accounts are only made up to May 31, 1891. The English ones cover the period to June, 1891. The reason for this is as follows: For the convenience of an early presentment of accounts to shareholders in the future, it has been thought desirable that the American stocktaking, which has hitherto been a somewhat tedious and lengthy operation, should take place a month before the English stocktaking, which is not so difficult to deal with. This year that offers the disadvantage that we have, as regards the American concern, a month's less profit in the year. The advantage which that arrangement will give us, under ordinary circumstances, has not been felt by the Board in the present year, because we have been unable to present our accounts as early as we should desire, and as it is our purpose to do in all subsequent years. The delay has been caused by the difficulty of taking the stock in America, from questions arising between the vendor and the Company during the year, and from a change in the method of keeping accounts in the English undertaking, which was suggested by the Auditors. All these practical reforms have now been accomplished, and in future we hope to hold our general meeting at an earlier period than in the present year. Now, if we had included the month of June in the accounts of the American business, the profits would have been increased to the extent of several thousand pounds; and, of course, if that had been done, it might have enabled us to cover a dividend upon the present ordinary shares. I only hope that the ordinary shareholders will receive next year the benefit of the abstinence from a dividend which the month of June might have enabled them to obtain. In common with all industrial undertakings, especially in America, the last nine months, or, I should say, perhaps, the nine months between September and June of 1890-91, was a time of extraordinary pressure and very great difficulty. Lots of you know that the finances of America, so far as industrial undertakings were concerned, were entirely disorganised, and, as the report points out, in an enterprise of this kind the pressure was so great that a highly flourishing business had to be reorganised. And permit me to correct a too strong expression as used in the report. It speaks of the failure of the Westinghouse Company. That is too strong a term to be applied to that concern, which, though it was suspended, has been reorganised. I am anxious not to speak of this matter as a failure, but prefer to call it the reorganisation of the company. Bear in mind that while that was the condition of things during those nine months in industrial operations in the States, a period of revival has set in, and we are already receiving the benefit of it. Not merely in England; not merely from the fact that our English works are now engaged in the production of our specialities in okonite wire—and therefore we are anticipating a very considerable increase in our English connection and business—but an absolute revival has taken place in our American business also. The panic is at an end, and the business since we made up our accounts is several thousand dollars in excess of the business from January to May. There is, therefore, abundant evidence that the business is a healthy and profitable one, and that when we meet the shareholders again next year, unless some unforeseen misfortune overtakes us, from which no industrial enterprise is absolutely free or safe, our meeting will be much more satisfactory than that which we are now holding. Our Manchester business has been very much hampered and curtailed by the fact that we have been compelled to move our machinery. Now that is all completed, and the business is in first-rate working order. We have no doubt whatever—I am quite sure that Mr. Shaw, who represents us there, will confirm me—that there is every prospect of a thoroughly healthy English business, to which I attach much importance, as being more easy of superintendence and not so subject to fluctuations and depreciation. Everything that I have said is simply an enlargement of what is given in the report. The policy of the Board is unanimously to have no secrets from the shareholders; to have no dodging in the management of the business; but to tell shareholders fully, fairly, and honestly what the condition and character of the trade done is, and to divide profits fairly, totally irrespective of any other consideration but the permanent welfare of the Company and the interests of those who have invested in it. As Chairman let me say that the most cordial co-operation prevails t only among the members of the Board in England, but tween them and the Management Committee, who are also rectors, in America. The hopes which I have expressed are animously entertained by both sections of the Board. Our siness in Manchester, and the business in America, which has therto been successful, combined, will, I hope, enable us to ake the Company one of the first connected with the manufacture electrical wire. If any shareholder desires to ask any question will endeavour to answer it.

Sir Alexander Armstrong, **K.C.B.**, **F.R.S.**, seconded the otion.

Mr. Squire called attention to the amount of stock-in-trade, hich showed, he said, that they had paid £195,545 for goodwill, hich seemed to him a very large sum. He would like to now whether the legal gentlemen connected with the Company hen it was agreed to purchase the £21,711 profits that had been rned from January to June, 1890, did not know that that was oney that could not be divided among the shareholders as ividend? It ought not to have been put in the prospectus as istributable dividend. On the Dr. side of the balance-sheet he aw loans, sundry creditors, etc., £56,250. That was a large mount for a Company supposed to have a large capital of nearly 400,000, to be taking credit for. If they went into the market ith ready money they could get things cheaper. It seemed to im that they had paid too much for their goodwill, and had ought obsolete plant.

The **Chairman**, interrupting, said that none of the plant was bsolete. The new plant they had put up had been entirely for he construction of their speciality in okonite wire. So far as he new, not a single machine had been discarded as obsolete.

Mr. Squire accepted the correction, but would like an answer s to the profits and the loans and sundry creditors.

Mr. Peters thought, considering that the Board were dealing with a capital of some £400,000, they might have given the shareholders a trading account. They had jumbled up altogether "by profits on American business £47,862," and then lower down "by purchase of properties and businesses in America and Manchester £324.990," less certain deductions. He thought they ought to be able to form a correct opinion as to whether the expenses chargeable to trading account bore a fair proportion to the profit earned. He would like to know how much out of that net sum which represented the great asset of £218.979, was really represented by *bona fide* goodwill and nothing more? When they paid the interim dividend up to December, 1890, amounting to £10,694, the Directors told them they had every reason in justification of that payment. Everything looked fair and right, which no doubt was the case. But considering that that payment only left £7,059 altogether, he would scarcely have supposed that any Board would have paid a dividend right up to the hilt. For this reason it appeared to him that they had made no profit at all for the last six months.

In replying, the **Chairman** said that as regarded the profits derived from trading, the Directors did not think it would be advisable to make a statement public, because it might be made available for the purposes of their rivals and customers. That was the only reason why they and other large companies (Armstrong's, for instance) did not publish the details of their trading. But if any shareholder wanted information, their managing director (Mr. Stevens) would be very happy to give it him. As to Mr. Squire's questions, only those profits could be divided which had been made during the existence of the Company, and the purchase of the indivisible profits (£21,711) must of necessity be the purchase of an asset which could not be divided as dividend among the shareholders. He could only say that the purchase of 21,711 sovereigns for £21,711, though not particularly profitable, was fairly satisfactory. The real reason why these profits got to such a pitch was the delay in the registration of the Company. The purchase of the American business was fixed for January, 1890, but owing to circumstances the registration of the Company could not take place until June. In the interval, the profits to which they were entitled under the contract as from January 1st swelled to the amount mentioned.

A **Shareholder** pointed out that he became one under the idea that these profits were divisible, and he wanted his share of them. Other shareholders concurred.

The **Chairman** said he had no doubt that if a prospectus was presented to a layman with a statement in it of profits earned before the registration of the Company, he would look upon them as divisible. The legal mind would not have so regarded it. He freely admitted that every shareholder was entitled to grumble. But they must admit that they got their share of them, not in their pockets, but in the ultimate benefit they would derive by reason of the reduction of the capital, the amount being appropriated to that purpose. As to another question, the amount which was appropriated to goodwill was very easily ascertainable from the prospectus, because the valuation of real estate was given there in full, and the amount given for the goodwill was, in fact, the difference between the valuation of the real and other estate, and the amount of the purchase-money. He believed the amounts for goodwill would work out to £11,000 for the Manchester business, and £80,000 for the American, or £91,000 out of £218,000 might be taken as representing goodwill, processes, patents, and other matters of that kind.

In answer to another shareholder, the **Chairman** said that the Manchester works were now in full working order. Their okonite samples were now before customers, and they expected to have orders almost immediately. The capital expenditure had been completed. They had commenced working within the past fortnight. They were endeavouring to introduce okonite wire into all possible forms of consumption, but it was right that he should say that as yet the cable companies' electricians preferred guttapercha-covered wire to any other form of insulation for submarine cables.

Shareholders having expressed a wish to hear Mr. Stevens, managing director, the Chairman then called on that gentleman. He said he did not wish to go into details, but would be pleased to give information as to the prospects of the business to any shareholder if he would call at the office. They were closely watched, and were in competition with firms of great standing and considerable wealth, and any information given publicly was likely to be used to their disadvantage if it concerned details as to prices and profits. They were not relying solely upon any one branch of their business. Their managers and employés at the Manchester works were skilled men, who were thoroughly acquainted with their business. For years Messrs. Shaw and Connolly had been carrying on an indiarubber insulated wire business. To that they had added the okonite business and that of making guttapercha and compound covered wires. The compound was made of paper or cotton, or some form of dielectric of that sort insulated with oil. They had also laid down, in America and England, a most extensive lead-covering plant which was likely to lead to large orders. They were now on the list of contractors to the Admiralty, which was a very important consideration, and this would be followed by their being on the War Office list also. It was important, because before they could get on that list their works were examined by a Government inspector, as the Government would not allow them to contract unless they were in a position to do so. There were only three contractors on the list at present, and they meant to get into that close corporation and obtain their proportion of orders. This business would of itself pay a very respectable dividend on the capital employed in their English business. Railway companies were very conservative, and did not care about moving until they were well satisfied. They had submitted samples to some companies, and had small orders, satisfaction being expressed with the goods. They had supplied one or two very large installations, and would in a short time be able to get their full share of work—a share to which they were entitled as being, with the exception of one company, the most powerful company in England, and having the most complete works. In America, they were far and away first. He had been to America twice since the Company took over the American business. He found it most admirably managed, but by people who had taught themselves in a great measure. They were expert electricians, but had not had the experience which came from long handling of such a material as rubber. Mr. Connolly went over there, and looked after the technical part of the business. He learned their okonite business and taught them processes which would be of use to them. He (the speaker) looked into the business part, and several alterations necessary to fit in with English ideas had been carried out. The accountants to the Company, who had a branch in New York, sent over monthly balance-sheets which afforded a perfect check. As to the progress made in England, he thought it was highly satisfactory. Month by month the sales were increasing. During the time they had been manufacturing in Manchester, they had had to build up their factory through a very bad winter which had interfered with the operations. They had also had to manufacture their own machines, because they would not let them be made outside. They bought castings all over the country, and put them together themselves. During this time they had had to keep moving their machinery about in order to execute orders, but now they were completely equipped.

Mr. Shaw, one of the Manchester managers, also spoke, and dwelt on the bad times the electrical industry had gone through. Since June, however, they had been steadily increasing their turnover. September was 30 per cent. better than the same month in 1890, and October was better still. The moment he was able to place okonite manufactures they would be doing a very big business indeed. His customers were applying for them, and he thought there was a good prospect before the Company during the next twelve months.

The **Chairman**, after some remarks as to the good to be derived from holding a friendly conference with shareholders, put the resolution adopting the report and accounts, and it was carried unanimously, as also was a resolution confirming the declaration of a dividend at the rate of 8 per cent. per annum upon the preference shares, and the application of the balance of £259. 7s. 2d. to the reduction of preliminary expenses. The Chairman remarked that the dividend would be paid in a week or ten days.

The auditors, Messrs. Price, Waterhouse, and Co., having been elected, a vote of thanks to the Chairman was passed, and the proceedings closed.

COMPANIES' REPORTS.

EASTERN EXTENSION TELEGRAPH COMPANY.

The Directors, in their report for the half-year ended June 30, state that the gross receipts, including Government subsidies, amounted to £264,878, against £254,856 in the corresponding period of last year. The working expenses, including £17,318 for cost of repairs to cables and expenses of ships, absorb £71,746, against £76,670. Deducting income tax, interest on debentures, debenture stock, and contributions to sinking fund, and £2,179 for special expenditure, there is £155,165 available. One quarterly interim dividend of 1¼ per cent. was paid during the half-year, and another of like amount will be distributed on the 15th inst., leaving £92,665 to be carried forward. All the 6 per cent. debentures that were outstanding when the last report was issued have been paid off and cancelled, and the Stock Exchange have granted an official quotation in the new 4 per cent. debenture stock. An arrangement has been concluded with the Dutch Government for connecting by submarine cable Sumatra with Penang, so as to bring the Netherlands' Indian Government telegraphs into direct communication with the Company's system at Penang. The cable for this purpose will be taken from the Company's depot at Singapore, and laid in the course of the next few months.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.

The report of the Directors states that for the half-year the revenue amounted to £156,905 3s. 1d., and the working expenses to £25,449. 5s This very exceptionally increased revenue mainly arises from the disturbed state of affairs in South America. After providing £12,880 for debenture interest and sinking funds and £2,320. 2s. 9d. for income-tax, there remains a balance of £118,255 15s. 4d.; to this is added the sum of £11,121. 4s. received in respect of traffic receipts between March, 1889, and December, 1890, hitherto under dispute, and £23,833 17s. 5d. brought forward from December 31st last, making a total of £153,210. 16s. 9d. A quarterly interim dividend amounting to £32,500 has been paid, and £60,000 transferred to the reserve fund, increasing that fund to £474,878. 7s. The Directors now recommend the declaration of a final dividend of 1s. per share, making, with the interim dividends, a total dividend of 6 per cent. for the year, and also the payment of a bonus of 4s. per share, both free of income tax, which together will amount to £32,500, leaving a balance of £28,210. 16s 9d. to be carried forward. The dividend and bonus will be payable on the 22nd inst.

CITY NOTES.

Brazilian Submarine Telegraph Company.—The receipts for the last week were £4,901.

City and South London Railway.—The receipts for the week ending October 11 were £747, against £748 for the week ending October 4.

Western and Brazilian Telegraph Company.—The receipts for the week ended October 9, after deducting 17 per cent. of the gross receipts payable to the London Platino Company, were £3,797.

Direct United States Cable Company.—The Directors recommend an interim dividend of 3s. 6d. per share, tax free, being at the rate of 3½ per cent. per annum for the quarter ending September 30, payable on the 24th inst.

St. James's and Pall Mall Electric Light Company—The value of the electrical energy sold by this Company for the quarter ending 30th September last amounted to £5,279, as against £1,818 for the corresponding period of last year. The value for the quarter ending June 30 was £6,632.

PROVISIONAL PATENTS, 1891.

October 5.

16870. **Improvements in the combination of electrical brush, brush-holder, and lubricator.** Tom Sutcliffe and Edward Harold Atkinson, 19, King's-road, Finsbury Park, London. (Complete specification.)

16875. **Improvements in automatic electrical apparatus for signalling and preventing accidents on railways.** James Grant, 87, St. Vincent-street, Glasgow.

16895. **Improvements in electric arc lamps.** James Blewitt Spurge, 2, Gloucester-chambers, Gloucester-street, London.

16931. **Improvements in electric meters.** Emile Charles Grassot, 45, Southampton-buildings, London. (Date applied for under Patents Act, 1883, section 103, 4th April, 1891, being date of application in France.) (Complete specification.)

October 6.

16934. **Improvements in secondary or storage batteries.** Henry Harris Lake, 45, Southampton-buildings, London. (Patrick Kennedy and Charles Joseph Diss, United States.)

16938. **Improvements in secondary or storage batteries.** Henry Harris Lake, 45, Southampton-buildings, London. (Patrick Kennedy and Charles Joseph Diss, United States.)

16958. **Improvements in or relating to metallic junction-boxes or cases for conductors or fittings for electric lighting electric bell circuits, and like purposes, and in the mode of connecting the conductors thereto.** Henry Alexander Mavor, William Arthur Coulson, Sam Mavor, and William Brooks Sayers, 62, St. Vincent-street, Glasgow.

16989. **Improvements in printing telegraphs.** Henry Harris Lake, 45, Southampton-buildings, London. (Moses Gerrisch Farmer, United States.) (Complete specification.)

16941. **Improvements in switches for electric lighting.** Andreas Peter Lundberg, 18, Fulham-place, Paddington, London.

16991. **Improvements in type-printing telegraphic apparatus.** Frederick Herbert William Higgins, 24, Southampton buildings, London.

16999. **An improved thermostat.** Charles Madison Martin and Alphonse Edouard Tavernier, 4, South-street, Finsbury, London.

17003. **Machines for making grids for secondary batteries.** Albert Franklin Madden, 1, Queen Victoria-street, London. (Complete specification.)

October 7.

17032. **Duplex plates or discs for electrical health appliances.** Thomas Smith and James Cochar Hall, 5, Rokeby-road, Brockley, London.

17042. **Improvements in and relating to dynamo-electric machines applicable for the traction or propulsion of any vehicle, vessel, or body, as well as for all purposes to which dynamo-electric machines may be suitable** John McHaffie, 70, Wellington-street, Glasgow.

17074. **Improvements in electrical subways.** John Cecil Reilly, 1, Quality-court, London.

October 8.

17107 **Improvements in electric arc lamps.** John Hall Rider, Northern Telegraph Works, Halifax.

17118. **Improvements in arc lamps.** Theodore Tubini, 76, Oxford-gardens, North Kensington, London

17119. **Improvements in electrical switches.** William Charles Cheesewright, 96, Wardour-street, London.

17148. **Improvements in electric switches.** William Brooks Sayers, 46, Lincoln's-inn-fields, London.

17160. **Improvements in and relating to electric accumulators** Henry Harris Lake, 45, Southampton-buildings, London. (La Société dite Electriciteits-Maatschappij (Systeem de Khotinsky, Germany)

October 9.

17192. **Improvements in electric distribution.** Arthur Wright, 26, Park-crescent, Brighton.

17220. **Improved means and apparatus for commutating or rectifying an alternating current.** Sebastian Ziani de Ferranti, 24, Southampton-buildings, London.

17227. **Improvements in electric cables.** John Charles Howell, 55, Chancery-lane, London.

17231. **Improved winding for drum armatures of dynamos and electromotors** Siemens Bros. and Company, Limited, John Nebel, and Frank Harry Valter, 28, Southampton buildings, London.

October 10.

17264. **An improved self-winding electric clock.** John Rich, 106, Victoria-chambers, Chancery-lane, London.

17291. **Improvements in electric soldering irons.** Willis Mitchell, 35, Southampton-buildings, London. (Complete specification.)

17310. **Electric signalling apparatus for use with a network of electrical lines or conductors.** Ludwig von Orth and Emil Breslauer, 46, Lincoln's-inn-fields, London.

SPECIFICATIONS PUBLISHED.

1890.

15828. **Dynamo machines.** King. 6d.

18791. **Fixing telegraph wires to insulators.** Imray. (Baptista) 6d.

1891.

10347. **Electric battery.** Fitzpatrick. 6d.

12070. **Reciprocating the anchor of an electric apparatus.** Fitzpatrick. (Scholler and another.) 6d.

12541. **Dynamo-electric machines, etc.** Cuénod and others. 6d.

13171 **Incandescent electric lamps.** Criggal and others. 6d.

13269. **Electrical glow lamps** Gimingham. 6d.

13653. **Stereotype and electrotype plates** Reid. 8d.

13753. **Telegraphic call-boxes.** Clark. (Noyes). 6d

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Brush Co.	—	3⅝
— Pref.	—	2
India Rubber, Gutta Percha & Telegraph Co.	10	19¾
House-to-House	5	5
Metropolitan Electric Supply	—	10
London Electric Supply	5	2
Swan United	3½	3½
St. James'	—	8½
National Telephone	5	4½
Electric Construction	10	[illegible]
Westminster Electric	—	6

NOTES.

Dundee Tramways.—The burgh engineer of Dundee has been instructed to prepare a scheme for the extension of the tramways.

Kimberley.—Arrangements are being made, we learn, for holding a universal exhibition at Kimberley, Cape Colony, during September, 1892.

Institution Dinner.—The third annual dinner of the Institution of Electrical Engineers will be held at the Criterion Restaurant, Piccadilly, on Friday, Nov. 13.

Derry.—We learn that the spirited enterprise of Carlow and Larne have caused the authorities of Derry to decide upon having the electric light for the coming season.

Liverpool Electrical Laboratory.—The electrical laboratory of the Liverpool School of Science is so well attended that it has been necessary to open it on Thursday as well as on Friday evenings.

Bilston.—On the recommendation of the General Purposes Committee, the Bilston Township Commissioners at their meeting last week accepted the tender of the Brush Electrical Company for lighting the Market Hall by electricity.

Brussels-Amsterdam Telephone. — A despatch from Brussels states that at the beginning of next year telephonic communication will be opened between that city and Amsterdam. The line will pass through Antwerp and Rotterdam, where telephone stations will also be established.

Aberdeen.—The electric lighting scheme seems to be in an undecided state in Aberdeen. It will be remembered that a project was brought forward by Mr. Liardet for the use of water power. This has not been as yet accepted, and no definite proposal has been laid before their consulting enginer.

Rotary Currents.—Messrs. Siemens and Halske, before the close of the Frankfort Exhibition, installed a rotary-current motor, having an armature of the usual Gramme type with three brushes on the commutator. The speed can be varied within wide limits, and it is intended to use this motor for tramway work.

Mansion Lighting.—Messrs. Drake and Gorham have just completed and successfully started up another private house, which has been lit on the special system which they employ for work of this kind. Shendish, near Hemel Hempstead, has been lit for Mr. A. Longman. The installation consists of about 100 lights.

Eastbourne.—At the meeting of the Eastbourne Town Council last week, the proposal to connect the pavilion with the Corporation electric lighting system was raised, Councillor Blaker asking why the lamps at present in use could not be utilised for the new system. It was stated that they would not stand the test of the high-pressure system.

Mansion Lighting.—A complete electric lighting installation is being erected at the Mansion, Doublebois, Cornwall, under the superintendence of Messrs. Morgan Williams and King, consulting electrical engineers, Victoria-street, Westminster, the prime motive power being derived from a petroleum engine. Mr. F. M. Newton, of Taunton, is the contractor.

Huddersfield.—At the meeting of the Huddersfield Town Council on Wednesday, it was decided to make application to the Local Government Board for power to borrow £50,000 for electric lighting purposes, but before absolutely borrowing the money the Gas Committee should see what the Finance Committee could do in the way of finding the money.

Leamington.—When the letter from the Aurora Electric Lighting Company was read at the Leamington Town Council meeting, Councillor Crowther suggested a reply should be sent, "Once bitten, twice shy." Councillor Bright said the Aurora Company offered to supply current at about half that which they were before paying. The town clerk was instructed simply to acknowledge the letter.

Electric Carriage.—M. Malignani, director of the electric station of Udine, France, has built himself an electric carriage with a battery of special construction, and a motor geared to the axle. The carriage travels at eight or 10 miles an hour, and the cost is given (without details) as 1d. per car mile for a six-hour run. The car takes three persons, and M. Malignani is intending to further develop his ideas to tramways.

Koechlin Electric Meter.—The meter invented by Maurice Koechlin, of Belfort, France, consists of a Wheatstone bridge arrangement, one branch of which includes the circuit to be measured, and another branch includes a variable resistance, the latter furnished with an electric motor device, whereby, if equilibrium be disturbed, the movement both balances the two resistances and registers the movement at the same time.

Yarmouth.—Only 200 applications for electric light having been received in answer to the advertisement by the Town Council, the surveyor does not consider such a meagre response warrants the Council in providing an installation. He suggested further attempts by private circular if desired, but the Council decided not to take further steps in the matter until they had visited other towns lighted by electric light.

Berlin.—A report of the Berlin Electrical Works shows that from the 30th June, 1890, to the 1st July, 1891, there was a large increase in the number of consumers—namely, from 872 to 1,314, being about 50 per cent.; the sale of lamps has increased from 74,959 to 104,100. Orders for an additional 25,000 to 30,000 normal lamps have been secured for next winter. Electricity is also much used for business purposes, the company having largely reduced their tariff.

Cost of Electricity.—M. Haubtmann, in a communication to the Société des Ingenieurs Civils, makes some comparisons between the cost of electricity in various towns. He gives the cost of the electrical horse-power in London as 3·75d., three times that of gas; in Paris it is 9d.; at Saint-Brienc ·52d. Fribourg, in Switzerland, has the honour of being the cheapest place for electric power in Europe: here it is 1½d. per electrical horse-power, falling to 1d. only for those taking over 20 h.p.

Sewers in St. James's.—A correspondent signing himself "Piccadilly" wrote to the *Times* on Monday complaining of the sewers in St. James's, attributing the fault to the electric light company forcing waste steam into the sewers. To this ridiculous complaint the managers of the St. James's and Pall Mall Company simply wrote stating that the company does not, either at its station or elsewhere, force waste steam into the sewers, but discharges it from a chimney shaft at the height of 130ft. above the ground.

Glasgow.—The long-desired conference between Sir William Thomson and the Electric Lighting Committee of the Glasgow Corporation has recently been held, and a general understanding has been arrived at that for the compulsory area of the provisional order the low-tension continuous-current system shall be adopted. For other districts where a demand for electric light may arise, it is contemplated to lay down additional stations of moderate size. All the members of the committee were present at the conference.

Telephone v. Telegraph.—A telegram from New York states that the Western Union Telegraph Company has just issued a notice stating that the New York Associated Press owed the company £10,000, which it was unable to collect, and that the telegraphic connection of the agency would therefore be cut off. The Associated Press declared that if the Telegraph Company carried out its threat it would adopt the telephone system in defence. In accordance with this announcement, the wires were cut on Tuesday morning.

Wire Fences as Lightning Conductors.—The American insurance companies which issue policies on cattle have been led to the conclusion that a distinct increase in the risk is caused by the use of wire fences on farms. The number of cattle reported as killed by lightning is very large. "Most of the animals," says a writer in the State of New York, "were near the wire fences at the time, and it is supposed the metal strands act as a conductor of electricity in a degree sufficient largely to increase the risks."

Chicago Buildings.—Interest being aroused in the wonders of Chicago, the latest of these may be seen by English engineers when visiting the World's Fair with great interest. It is an immense building for the Oddfellows' hall. It contains 1,100 rooms, and a tower 556ft. high, consisting of 40 storeys. The whole will be lighted from a private central station in its basement, which will supply 20,000 lamps for the building alone. The tower will be a landmark for miles round, and it is proposed to have an arc light display from the top.

Launches for Southport.—The Improvement and Foreshore Committee have recommended that the new lakes should be worked by the Corporation, and that boats and launches should be purchased at a cost of £5,000. The recommendation came before the Council at their last meeting, but without being adopted. It has again been referred to the committee for further consideration. The committee ought to be kept informed of the progress of electric launches, which are becoming such a favourite means of pleasure-tripping on inland lakes and rivers.

Train-Lighting.—One of the express trains running between Berlin and Frankfort is now lighted by electricity. Each carriage is furnished with two batteries of accumulators, and the lamps are fed on two distinct circuits, so that in case of accident one battery will still supply light. The cells are specially constructed to stand rough usage; they have a capacity of 200 ampere-hours. Each battery supplies current for four lamps of 8 c.p. for the carriages, and one 5 c.p. for the lavatory. The batteries weigh 6cwt. each, and are placed beneath the floor of the railway carriage.

Underground Railways for New York.—The Rapid Transit Commission have presented their recommendation regarding the solution of the problem in this city. The chief features of their plan are underground railways on each side of the city, and an underground railway across town, underneath Union-square and Fourteenth-street; express trains running on special lines at the rate of 40 miles an hour; electricity for power and lighting; the block system and the latest methods of ventilation. The railways would be 30 miles in length, embracing 100 miles of single line.

Sydenham Central Station.—The order to commence this station was given on September 16th, and the building is already up to the roof. The site is on a steep hill, and some idea of the excavation necessary is given by the fact that 4,000 tons of clay have been taken out. The dynamos are finished and tested, and the engines are expected to be ready at once. A hopeful fact is that already half the possible power of the station has been applied for in the Crystal Palace exhibition. Mr. Todd, late with the Electric Construction Company, has been appointed resident engineer.

Bray.—The electric lighting of Bray, which has been entrusted to Messrs. J. E. H. Gordon and Co., will be carried out upon the continuous-current system. The reason which has led to the adoption of this system is mainly because it is intended to establish for next season a service of electric pleasure launches for the seaside. The esplanade will be lighted by arc lamps and the remainder of the town by a combination of arc and incandescent. Mr. Holehouse, chief draughtsman to Messrs. Gordon, is now in Bray, taking details of the mill in which it is intended to establish the central station.

Glover's Cables.—Messrs. W. T. Glover and Co. wish to call attention to their new registered telegraphic address—"Glovers, Salford." We are pleased to learn that this well-known firm has been very busy all the summer, and has been obliged to put down additional plant to meet the increasing demand for their manufactures. They have increased their stock of wires and cables, so that they can now rely upon delivering orders promptly. Mr. Henry Edmunds has now returned from the electrical congress at Frankfort, and can be consulted at Messrs. Glover and Co.'s office, 39, Victoria-street, Westminster.

Empress of Austria's Palace.—The International Electric Company has just completed the electric arrangements in the villa of the Empress at Corfu. The house and the extensive gardens are lighted by electricity, the lamps and lustres and candelabra being for the greater part adapted to the Pompeian style of the house. Incandescent lights are used for the interior, and large Swan lamps light the terrace and a portion of the landscape around. A perfect network of telephones and signals connects all the portions of the house and gardens with the town and the yacht "Miramar," that rides at anchor in the port.

New Accumulator Car.—An improved self-contained electric tramcar, from which considerable gain in economy is expected, has just been completed, to the order of the Birmingham Tramways Company, by Messrs. J. E. H. Gordon and Co., and is expected to be tried shortly. The car, which is a large one carrying 80 passengers, is mounted on two bogie carriages, and is driven by four motors directly fixed upon the axles working at slow speed. The gradual adoption of slow speed direct-driving motors for tramway work, both in this country as well as in America, seem to point to this form as that likely to eventually survive.

Influence Machines.—We heard incidentally the other day that Mr. J. Gray, the author of the work on "Influence Machines," is engaged upon experiments upon the efficiency of these static electrical machines, with an ultimate idea, no doubt, of investigating the possibility of the use of influence currents for lighting. The recent experiments of Tesla, approaching the subject from the dynamo machine side of the question, have created a great interest in high-tension alternating currents. Now that inventors seem to be applying their minds to the utilisation of the influence machine, Mr. Gray's very careful work in this direction will receive recognition.

Honours for Prof. Helmholtz.—The German Emperor has appointed Prof. Helmholtz to the honour of Privy Councillor, with the title of Excellency, addressing him as a man whose "great mind, always engaged in the pursuit of the purest and highest ideals, has in its lofty flight left politics, and the party intrigues connected with them, far behind it. I and my people are proud to be able to call so eminent a man as yourself ours." The honour is the more appreciated that it was given on the anniversary of the birth of the late Emperor. The high distinction conferred upon Prof. Helmholtz has created a great impression in Germany, being regarded as a national event.

New Journal.—The progress of electrical science in America is nowhere more apparent than the room there seems to be for continual additions to the technical journals. *Electricity* is the name of the last one, of which we are in receipt of the eleventh number. It is published in Chicago and New York. The number before us is well printed, and contains a pictorial illustration of thrashing by electric light, and photographs of different forms of lightning discharge, the "Story of the Richmond-road" (an interesting historical sketch by Frank J. Sprague), and the usual trade notes. We understand that Mr. Herbert Laws Webb has an appointment on the staff of the new paper, which we wish all success.

Edinburgh Association of Science and Art.—The first meeting for the session of this association was held on Monday, at the Society of Arts Hall, Edinburgh. Prizes were awarded, amongst others, to J. Stephen, for a paper on "The Evolution of the Electric Telegraph." Mr. James M'Laren exhibited and described an electromagnetic gas controller, for use in premises where the electric light is used, designed to turn up the gas light should the electric light break down. Mr. M'Laren also described a hydro-electric lift, one of the features of which was that its motions were regulated by a plunger which worked in a cylinder filled with water or some other fluid. Mr. M'Laren was thanked for his papers.

Valuing the Plant at Glasgow.—With the ultimate view of acquiring the central lighting station in Glasgow, owned by Messrs. Muir, Mavor, and Coulson, Limited, together with the machinery, plant, goodwill, etc., the Electric Lighting Committee of the Town Council recently received from that company a statement of the value which they put upon the whole concern, together with their balance-sheets for the last three years. A professional accountant (Mr. James Muir, C.A.) was brought in to report upon them, and Mr. Latimer Clark was called to his aid in matters with which he is professionally and practically familiar. It is thought that the terms of purchase will shortly be agreed on.

Tenders for Portugal.—The Municipal Chamber of Braga (Portugal) urban and rural, invite tenders, during three months from 5th inst., for the public and private lighting of the city of Braga, either by means of gas or by electricity. The particulars and conditions for making simultaneous, but separate and distinct tenders for these works can be seen in the Municipal Offices, Braga. Persons desirous of tendering should obtain the official form of tender from the offices, fill it up correctly, without superfluous details, and sign it before a public notary. Tenders containing more than is required in the official form will be null. The basis for tendering both for gas and electric light will be 17 dols. (about £3. 15s. 6d.) per lamp.

Leeds Electric Tramway.—It was intended, as we announced last week, that the Roundhay electric tramway should be opened yesterday, but the very wet weather delayed operations, and it is now announced that the line will be formally opened next Thursday. The line is about 5½ miles long, mostly through a suburb bordered on one side with trees—as suitable a run as possible for overhead lines. On Thursday the committee visited the shed at Burmantofts, and inspected the six cars which are now ready. It was decided to grant licenses to allow them to run. A trial trip will take place in a day or two. Mr. Graff Baker has been working very hard to make this line a thorough success, and has gained many converts to the overhead system.

Mansion House.—At a meeting of the Court of Common Council on the 15th inst., Mr. G. E. Wood moved the adoption of the report of the General Purposes Committee to consider the best means of lighting the Mansion House by electricity, and to obtain and submit tenders and estimates for the necessary works, and for authority to expend a sum not exceeding £1,500 in making the necessary arrangements. Mr. Wood observed that the committee found that Mr. Preece, their adviser, would have to report further before the installation could be carried out entirely, and the committee now asked for authority to spend this £1,500 in electric fittings. The report was referred back to the committee for execution.

Larne.—The electric lighting of Larne, Ireland, is now being carried out temporarily on the low-tension system. The permanent installation is being rapidly erected, and will consist of high-tension alternating distribution to fixed transformers, and a low-tension distribution to the houses. There will be eight of these transformer centres, of 5 h.p. to 10 h.p. each. The public lighting will be partly arc and partly incandescent. The dynamos will be driven by steam engines, the station being in the centre of the town. An interesting point about this installation is that the high-tension conductors will be all placed in heavy insulation safe underground, and the low-tension mains will be of bare copper wire, carrying current at 100 volts, run overhead along the streets.

Extension.—We are always glad to note the continued and extending activity of the younger firms of electrical engineers. The firm of A. B. Gill and Co., dating from the earlier days of the City Guilds college work, has advanced very rapidly into the front rank of electrical contractors, and the recent move into imposing premises opposite the Houses of Parliament showed the progress both already made and promise of that to come. We note that this firm, amongst other contracts, have just secured that for fitting up the Mansion House National Safe Deposit and the offices attached. The continued increase of business will shortly necessitate, we understand, considerable extension of their manufacturing works at Bermondsey. Besides the usual fittings, Messrs. Gill have their own type of dynamo and motor of careful and efficient design.

Blackpool.—The following resolutions are stated to have been arrived at by the local authority of Blackpool meeting in private last week, and have been communicated to the local paper: "That the clerk and accountant be authorised to communicate with the following firms of electrical engineers upon the question of machinery and fittings for the installation of electric lighting in this district: Messrs. Crompton and Co., Limited, London; Messrs. S. Z. de Ferranti, Limited, London; Messrs. J. E. H. Gordon and Co., and Messrs. Shippey Bros." "Resolved unanimously, that the chairman and clerk be authorised to interview the general managers of the Lancashire and Yorkshire and London and North Western Railway upon the question of electric lighting their various properties in this district, with power to interview other large employers of labour, and occupiers of workshops."

Deputations.—Several of the corporations of our larger towns have determined, not only to employ the services of an electrical expert, but to see for themselves before committing themselves to the expenditure necessary for town lighting by electricity. The members of the Glasgow Corporation recently had a jaunt to Frankfort, and last week a similar party departed from Charing Cross by the club-train for Paris. The party consisted of Mr. Alderman Carey, Mr. Lascelles Carr, the town clerk, and the borough engineer of Cardiff, and their consulting electrical engineer, who were deputed by the Cardiff Town Council to visit the Frankfort Electrical Exhibition in view of the proposed adoption of electric lighting in Cardiff. Besides Frankfort the deputation will visit Paris, Brussels, Cologne, Berlin, and Vienna, and on returning to England they will visit Leeds and several of the Yorkshire towns, to inspect the electric light installations.

Glasgow Fire Brigade and the Telephone.—By the adoption of a special form of portable telephone, the efficiency of the Glasgow Fire Brigade is likely to be considerably increased. About six months ago the National Telephone Company, on the suggestion of Firemaster Paterson, fitted up a telephone specially adapted for brigade purposes, and as a result of the experiment the hose and ladder carriages will now carry it at every turn out. The telephone is enclosed in a small box, and comprises a complete receiver, transmitter, and magneto call bell, no battery being required. On the arrival of a brigade at a fire, one or more of these portable telephones is at once attached to the nearest fire-alarm box, and communication is established with headquarters. The detachment engaged at the outbreak is thus kept thoroughly in touch with the rest of the system. The advantage of this important addition to the brigade plant has already been proved on several occasions. No other brigade in the kingdom, it is stated, has as yet made use of the telephone for such a purpose.

New St. James's and Pall Mall Station.—A new central electric supply station is being erected by the St. James's and Pall Mall Electric Light Company for the supply of the upper portion of their district, consisting of the very desirable region from Regent-street to Oxford-street. The new station is in Carnaby-street, out of Beak-street, near the Piccadilly end of Regent-street, and work is now proceeding upon the buildings. The Carnaby-street station will contain 3,000 h.p., with the same type of arrangement adopted in the Mason's-yard station. The three large engines and dynamos which have attracted so much attention in the central station of the Naval Exhibition have been purchased by the St. James's and Pall Mall Company for this new station. These are of 300 h.p. each. Other sets, each of 300 h.p., will be installed, but plans are now being got out for two sets of 600-h.p. engines and dynamos. Huge trunk mains will join the two stations, and these, part of which are already laid, are used to supply the northern district pending the opening of the Carnaby-street station, which is not expected to be ready until next year's winter season. It may be interesting to add that, from the published returns of the St. James's Company, a revenue of £21,406 has been earned at their Mason's-yard station on the first three quarters of the year, as against £5,627 for the preceding year.

How Business is Lost.—We understand that in many mining districts in New Zealand small dynamos are being introduced for lighting purposes. In some parts the dynamos are driven off an engine burning coal or wood, but in many places an engine is not permissible. The motor most appreciated seems to be the Pelton waterwheel. This waterwheel is of American manufacture, the head offices being at San Francisco. A No. 2 motor has a wheel 12in. in diameter, and can be coupled direct to the dynamo shaft. The head of water required must suffice to give a pressure of 140lb. per square inc[illegible] [illegible]nish a speed of [illegible] revolutio[illegible] minut[illegible] this arrang[illegible] about 65 incandescent lamps of 16 c.p. can be run. The Americans have flooded the colonies with advertisements of their wares, and similar productions of English manufactures are almost unknown. In scores of cases where water is available Pelton wheels are being used or suggested, not only for electrical, but for other purposes where power is required. Most Englishmen seem to imagine that their wares are known everywhere, but this is a mistake, and the American houses are not slow to take advantage of it. Quite recently we have seen colonial indents for electric light plants which in every case specified Pelton waterwheels—in fact, talking with a gentleman only just returned from one of the mining districts, it seems that no other similar apparatus is known in some places.

Edison's Electric Tram.—We usually hear more in Europe about Edison's new inventions than they do in America itself. The evening journals have been according great prominence for the last few days to Edison's new electric tram. We ventured to suggest last week that this might be simply a modification of the closed-conduit system, but it would seem from fuller particulars published that it is hardly even that. The "new electric street car invention," says the cable account, "is that a current passes down by one line of rails, is picked up by a bar, passes through the motor, and returns through the other line of rails to the central power station." Nothing very new in that. Let us see what further there seems to be. "The lower the voltage the less is the insulation necessary," . . . "the voltage of Edison's system is under 100 volts," . . . "a track of a quarter of a mile was laid, part on a grade of 300ft. to the mile with several sharp curves." . . . The chief feature is the pick-up. The invention acts well under six inches of mud and water. Details are withheld." It is true that this account comes from an untechnical source, and new ideas may have been carried out. But with the information before them, it is indeed strange that Edison should be credited in English papers with work on direct-current supply, with a pick-up from the rails for electric tram lines, when in our own country Mr. Magnus Volk at Brighton has shown the actual results with an electric railway of this kind for years.

Water Power Lighting for Inverness. — Last Saturday the Special Committee of the Inverness Police Commissioners, which has been appointed to make enquiries as to the best means of introducing the electric light into Inverness, met Mr. James Fraser, C.E., Inverness, and Mr. F. W. Lowe, representative of Mr. Frederick Nell, hydraulic engineer, London, the engineers appointed to make a report on the scheme, and accompanied them along the whole line of the Caledonian Canal. Provost Ross accompanied the party, which included Bailie Jonathan Ross, Mr. A. J. M'Ritchie, solicitor, and Mr. Macdonald, water manager. The scheme which most favourably impressed the engineers and the Commissioners was one by which water power should be obtained from the canal at the point opposite Holm Mills, where the River Ness flows close by. At this point a fall of about 35ft. could be obtained, sufficient to give about 400 h.p. This would more than meet the requirements of the town; and in course of an interview with the Commissioners, Mr. Davidson, the resident engineer, did not seem to think that the Canal Commissioners would object to giving the necessary supply of water. At present the Commissioners have, owing to the growth of the town and the rapidly-increasing consumption of gas, been called upon to expend about £10,000 on new plant and machinery; and it is estimated that all the streets and public buildings in Inverness can be lit up with electricity for about half that sum. Messrs. Fraser and Lowe's report is therefore being awaited with interest.

Crystal Palace Electrical Exhibition.—The question whether or not the electrical exhibition, to be opened at the Crystal Palace on the 1st of January next, will be thoroughly representative is most satisfactorily answered by the high standing of the firms who have already sent in applications for space, and by the varied nature of their exhibits. That the exhibition will form a complete record of 10 years' progress is now a matter of absolute certainty. The requests for space—which already exceed a total of 200—include electric lighting plants for country and town houses, for mines, for steamships, for railway trains, and even for private carriages. There are also included the newest forms of motors, generators, accumulators, and other machinery employed for producing and storing electricity. Not only will the most eminent British electrical and engineering firms, with scarcely an exception, be represented, but several of the more important exhibits at the Frankfort Exhibition will be transferred to the Crystal Palace. The apparatus section will include a complete set of Sir William Thomson's standard electric instruments, the latest improvements in telephony and telegraphy, new electro-medical and electro-thermic apparatus, and also the most recent electrical appliances for war purposes, blasting, and signalling. Special buildings are now in course of erection for boilers and other heavy machinery. The vast space in the grand central nave and galleries is now in course of allotment, and the various courts, concert hall, theatre, picture gallery, museum, dining saloons, etc., each of which will be used to illustrate different systems of domestic lighting and decoration, will shortly be allotted.

Telluric Currents and Eruptions.—M. Palmieri has made a series of observations at the occasion of the last eruption of Vesuvius, with reference to which he has presented the following report to the Royal Academy of Naples: "Last year I informed the Academy of two phenomena which I have noted at the Vesuvius Observatory during the solar eclipse of June 17, partial at that point—(1) a great recrudescence of the dynamic activity of the crater of Vesuvius, a recrudescence announced by abundant smoke, emitted with force, and coloured red by the chloride of iron, which is forced out in great quantity; by strong detonations and repeated rumblings; and by a large number of incandescent projectiles shot out to a great height. (2) The needle of the galvanometer inserted in the circuit of the telluric current underwent oscillations so continuous and so strong that it was impossible to take the definite galvanometric values of this current. I stated that the first of these facts were conformable to the law enounced by myself—a law established not only by my own observations during many years, but by retrospective study of all the great eruptions of Vesuvius, which have always taken place at the time of the new moon or at full moon. I had no explanation to offer of the second fact, and awaited opportunity of further observation. During the eclipse of 7th June this year, an eruptive phase sufficiently well marked was produced in the afternoon, accompanied by the same oscillatory movements of the new instruments substituted for the old galvanometer, which were repeated in exactly the same manner. It cannot therefore be pretended that this was a merely fortuitous coincidence."

Geneva.—The Swiss industries have achieved a position in the forefront of modern progress, in spite of the want of coal and minerals, by the extended utilisation of their splendid water power. Amongst the municipalities, Geneva has set a fine example of the use of the turbines for the supply of force, and a magnificent publication published under the auspices of the town authorities, entitled "Utilisation des Forces Motrices du Rhone," gives full particulars, drawings, and descriptions of these remarkable works, carried out under the direction of their engineer, M. Th. Turretini. The Lake of Geneva, in spite of its large extent, suffers considerable variations during the season. In passing Geneva the Rhone flows in two waterways surrounding an island. It was therefore possible by barring one arm to have the other free during progress of the work. A whole system, comprising reservoirs, buildings, turbines, and complete underground network of pipes for the distribution of force, is established. Twenty turbines, capable of giving 4,400 h.p., supply water at two pressures—60 metres and 140 metres. An immense reservoir, containing 6,000,000 gallons and costing £10,000, allows the installation to work night and day. The works, not yet quite complete, are for three purposes—the regulation of the water of the lake, the furnishing of power, and the carrying out of a main drainage scheme. This latter has already greatly reduced the cases of typhoid fever, which are now only nine per year. The number of motors is about 220, of a total of 150,000 h.p., not all, of course, used at one time. These range from ½ h.p. up to 625 h.p., the latter being used for electric lighting. The total cost was 7,000,000 marks, of which 1,000,000 was a subvention from other cantons. The power is sold 30 per cent. below cost. The installation has been carried out by Messrs. Escher, Wyss, and Co., of Zurich.

Electric Launches and Light for Paignton.—At the meeting of the Paignton Local Board on Monday, an interesting question was raised. Mr. W. Robertson, director of the Paignton Promenade Pier and Torquay Ferry, wrote that he was about to contract for several launches designed and constructed for service between Torquay and Paignton He contemplated having part of those launches propelled by electric motors, and in order to charge these launches it was necessary to erect a charging station, properly equipped with steam engines and dynamos. The same establishment could be arranged so as to supply electric light to the town of Paignton or to certain portions of it. Before deciding upon the power of the engines and dynamos to be put down, he would be glad to have the views of the Local Board on the subject, particularly whether in the event of his providing sufficient power to produce electricity to light the whole of Paignton the Board would adopt that mode of lighting, and if so, what amount per annum the Board would be prepared to pay for the same, and further, how many arc lamps the Board would undertake to pay for, and how much for each per hour of, say, 1,200 c.p. Several members supported the idea. The chairman said the question which arose was whether if anything was to be done in the way of electric lighting, it would not be better for the Board to undertake it and supply it to Mr. Robertson rather than for Mr. Robertson to have a monopoly and supply the Board. If Mr. Robertson obtained a provisional order and the Board wanted to make terms with him they would have to pay for it, whereas if the Board obtained an order they would be in a position to make terms with Mr. Robertson or to undertake the work themselves. Dr. Vickers said they had a mill stream, and if this could be used it would be cheaper than steam. Mr. Bridgman said he had been searching for particulars with regard to the question of electric lighting, but he had been rather reticent because they had a gas company in Paignton. Now, however, that someone proposed to move in the matter, he thought the Board should take the question up, and apply for a provisional order. He moved that the subject be referred to a committee of the whole Board. This was carried.

SHIPLIGHTING BY ELECTRICITY.

The importance of shiplighting by electricity can hardly be overestimated. At a time when land lighting seemed doomed to failure shiplighting was favourably received, and the orders given out for such lighting kept many a firm going. Progress, however, has taken place in such lighting as in ordinary station work, but even now there is too much work which partakes of the character of "vamping." We have, therefore, much pleasure in giving extracts from a new work on "Shiplighting," by Mr. Sunderland, electrical engineer at the Leven Shipbuilding Yard, Dumbarton, to be shortly published by Messrs. Biggs and Co., of 139-140, Salisbury-court, London, E.C. Mr. Sunderland is a most practical man, and whatever he says has been proved by experience.—[Ed. *E.E.*]

In lighting a ship the three main considerations are:

1. The generating plant.
2. The system of distribution.
3. The fittings.

The generating plant consists of (1) the engine, and (2) the dynamos. In selecting plant, people are often apt to attach too much importance to first cost, forgetting that a very cheap machine may turn out to be a very dear one in the end on account of repairs, besides which there is the risk of the annoyance through stoppage of the light. In these days, when so many improvements are being made in the machinery and methods of turning out work, it is impossible to make any hard and fast rule as to what plant ought to cost, but care should always be taken that the plant supplied is thoroughly good, no matter what the cost.

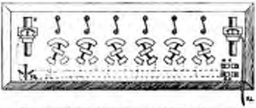

Fig. 1.—Main Board to be used with Two Dynamos.

In choosing plant we must carefully consider at what speed we must have it running. Within certain limits the slower the engine and the faster the dynamos the better, as any irregularity in the speed of the engine does not show in the dynamos, and a slow-speed engine is easier taken care of than a high-speed one. As the use of belts on board ship is seldom practicable owing to want of space and other considerations, and as spur wheel gearing is troublesome, it has been found most satisfactory to run the engines and dynamos coupled direct to each other. With this arrangement we cannot have a slow-speed engine and a high-speed dynamo. We do not wish too high a speed in the engine, and if we have too slow a speed any irregularity will tell on the potential at once and cause an unpleasant jumping of the lights, which will be increased if the armature is not perfectly balanced. I should therefore prefer a medium, say, about 300 revolutions per minute, and preferably a two crank engine, as with them the armature runs more steadily. They should be as simple and easy to get at as possible, so that any engineer without special experience may readily repair them.

Some engines though not difficult to manage, when you know them, are, owing to the way they are closed in, very difficult to understand at first, and marine engineers have so many small engines to attend to nowadays that they can't devote much time to them.

For this reason, a small compound double-acting engine of the marine type would be most satisfactory were it not that the high speed often slackens the bearings and causes them to knock in a very disagreeable way.

Rotary high-speed engines are frequently used, and they have the advantage of compactness and simplicity, but they use a great deal of steam per electrical horse-power.

The class of engine which seems to have given most satisfaction in driving dynamos direct is the single-acting engine. Some of them, however, are too difficult to get at, and the marine engineers are afraid to touch them. An engine of this type intended for ship use should be so made that the casings can be removed in a very short time and all the working parts easily accessible. Their main advantages are that they are efficient; that the pressure being on one side only, the bearings may be very easy without knocking; and, being cased in and self-oiling, they are very clean, thus not requiring much attention.

The governor is another important point. I have found the Pickering and the Acme to be the best. There is still, however, a want in this direction as with the best governors to be obtained at present, attention has always to be paid when the lights are switched off to prevent the potential from rising to high. There is, of course, the Parsons electric governor, a most ingenious apparatus, but it is not applicable to every engine; and I think there is still a great field for a simple governor controlled by the dynamo, and applicable to slow-speed engines.

Some years ago it was very common to see electric light engines with tachometers attached, so as to constantly indicate the speed. This, however, is quite unnecessary, as no one wants to know the speed so long as the potential is constant. The voltmeter tells you this at a glance. As the speed necessary to keep the potential constant varies with the number of lamps in circuit, it is a very awkward and unsatisfactory thing to work with a tachometer instead of a voltmeter. It is always a good thing, however, to have a tachometer in case you find that with full steam on you cannot keep up the potential, as you can then ascertain whether the engines and dynamo are going at their proper speed. If they are not, then you know that either the steam pressure is down or there is something the matter with the engine. If they are, then you know that the fault lies in the dynamos.

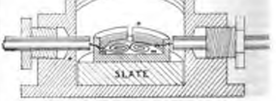

Fig. 2.—Section of a Two-way Junction-box.

The best way is to have one portable tachometer, which can be applied by hand to any of the dynamos, or to any other machine, and the speed ascertained at a glance. The oiling arrangements should always be made as perfect as possible, care being taken that no oil can be splashed on the dynamo. The dynamo also should be made as simple and accessible as possible. Good workmanship, with strong mechanical construction and simplicity, is often of more importance than great electrical efficiency. At the same time there is no reason why all four should not be combined. It is always advisable to have more than one dynamo if the ship is large enough to afford it, as in the case of a mishap to one a large number of lights may be supplied by the other or others, as the case may be. They should never be made too large, as it becomes difficult to take them apart for inspection or repairs. A dynamo capable of supplying 300 lights of 16 c.p. is as large as I should care to put into a ship, while one capable of supplying about 200 is a nice handy size.

The commutators which have been found to answer best are those having narrow segments made of hard-drawn copper insulated with mica. Care should be taken that the armature is properly balanced and runs perfectly true. Brushes, of which there should be always at least four, two a side, should be made to bear upon the commutator by means of springs, the pressure of which should be adjustable while the machine is running, and they should be provided with a simple arrangement for lifting them off without altering the set of the springs. Material which is liable to absorb moisture should never be used to insulate the commutator. I was recently called upon to examine a dynamo which would give no current at all when running at full speed. On testing, I found all the connections and general insulation perfect. As the commutator was insulated with asbestos, I came to the conclusion that the fault was due to moisture. The commutator was disconnected and tested, when the insulation came out very low. It was then put into an oven and roasted for some time, and the insulation became as good as ever. When joined up again the dynamo gave no more trouble.

A voltmeter should be attached to each dynamo, and so placed that it can easily be seen from the stop-valve. Fuses should be put on to both leads as near the dynamo as possible. The leads should then be led to the main switchboard, which, if there is more than one dynamo, should be so arranged that any dynamo can be connected in a few moments to any section of the wiring. An ammeter should be fixed on the main board, and arranged with flexible leads and clips, so that it may be instantly connected to measure the current passing from any dynamo. The principal object in having an ammeter is that the man in charge may know when a dynamo has its full load, and to enable him to distribute the work equally over all the machines. The only instruments suitable for measuring potential on board ship are the Thomson marine voltmeter and the Cardew voltmeter. The former is much more able to stand the vibration than the latter. Sir William Thomson has also designed a marine ammeter on the same principle, which has proved very satisfactory.

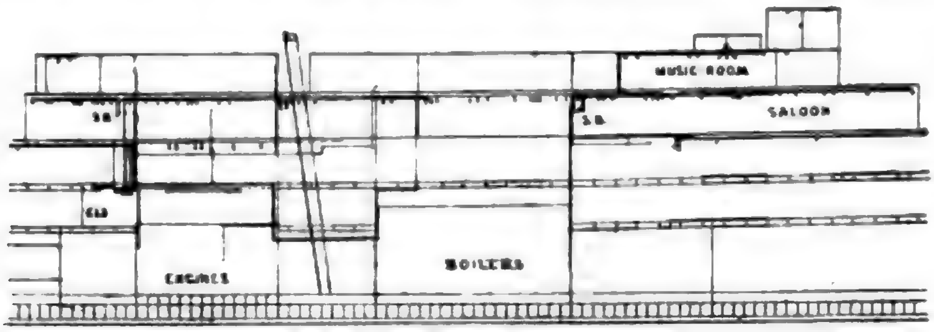

FIG. 3.

We will now look at the question of distribution. There are practically two systems—the double-wire system and the single wire system, the three-wire system being seldom or never used on board ship.

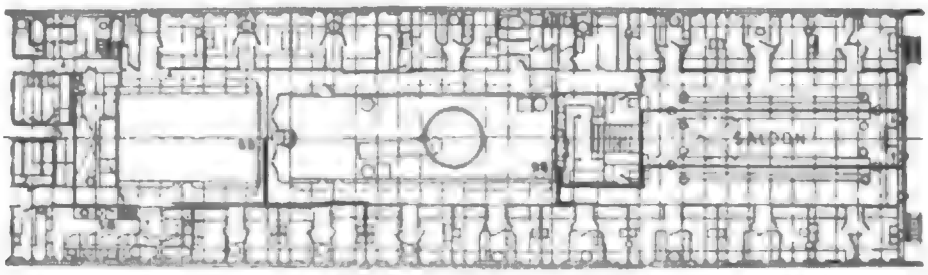

FIG. 4.

In the double-wire system a wire is led from each pole of the dynamo to the lamps, and in the single-wire system a wire is led from one pole of the dynamo to one side of the lamps, the other side and the other pole being connected to the hull of the ship. I put it in this way to avoid the terms positive and negative, for reasons to which I shall allude further on. To these we might add the concentric system, which is closely allied to single wiring. In it one conductor is placed inside the other, and as in most cases the outside conductor touches the ship's side at some points it is practically a single-wire system.

There is great diversity of opinion as to whether the single wire system should ever be used at all, and a great deal has been said against it, but it should be borne in mind that it has important advantages, and that single wiring does not necessarily mean shoddy work, as some are led to suppose. The principal disadvantage is the effect on the compasses, and on that account the single-wire system pure and simple should never be used throughout the ship. Double wiring should always be used in the proximity of the compass.

One of the greatest troubles to be overcome in ship-lighting is the presence of water, which gets into the fittings and causes mischief. This is much less liable to occur with the concentric fittings of the single system than it is where two wires are led down through a tube. The use of one wire greatly simplifies everything, and on a ship, where there is often a great number of wires and very little room for them, this is a great advantage. By using a system of sub-division, faults are more easily found out and put right than with the old system.

At Leven Shipyard, Dumbarton, this system has been used for some time, and considerable improvements have been made in it. The aim always in view is to make every part of insulated circuit watertight. The ship is divided into sections, and a main lead is run from a fuse and switch on the main board to an auxiliary board placed in a convenient part of each section. From this auxiliary board wires are carried to groups of not more than eight lights. Each wire is made large enough to carry eight lamps at 1,000 amperes per square inch, and this size is adhered to throughout. There is a switch and fuse on each wire designed to carry eight lamps of 16 c.p. They are easily got at, and no other fuses are necessary to protect the wires. After leaving the fuse, each wire passes along a wood casing to the first lamp in its group; here it is led into a back-block made of teak boiled in paraffin, to which is attached a watertight junction-box having one or more stuffing-boxes on its side. Through one of the stuffing-boxes the wire is drawn after it has been bared at the end. It is then attached to a screw junction, and from this junction another wire is led out in the same way to the next lamp; or if the circuit splits here, two, or perhaps three, wires are led out, making four wires in all. In practice, however, it is found that very few four-way boxes are required. In this way the wire is carried on until the last lamp of the group is reached. The stock of the pendant is screwed into the box, closing it up, and making it watertight. The pendant coming under the head of fittings, it will be sufficient at present to say that the stock and junction-box form part of the return. From the outside of the box an insulated wire is led. If it is desired to have a separate switch on the lamp, this wire is led to the switch, thence through a fuse to earth; but if no switch is wanted, a small fuse is attached to the junction-box, and the wire is led from it direct to earth. When I say earth, I, of course, mean the hull of the ship. The earth wires are joined to the skin of the ship by a $\frac{3}{8}$in. brass screw and a white brass washer, the iron being carefully cleaned first, and the pin then screwed hard up. The fuses mentioned are not necessary to protect the wires, the object of having them being to prevent one lamp putting out the whole eight in case of a short circuit occurring in it; the attendant then knows where to look for the fault. In the case of lamps which are near the compass, the earth wires are elongated and carried along the side of the lead until they are well away from it, and are then earthed like the others.

In the engine-room, stokehole, 'tween decks, etc., where the leads require mechanical protection, and have to stand heat, lead-covered wire with an outer coating of iron wire known as "armouring" is used. In this case we have the same boxes, the armour being joined to the outside; and as it is fastened by clips direct to the iron of ship, no other earth wires are necessary. When joints are necessary in the wires, the same boxes are also used, a blind brass cover being screwed in instead of the lamp stock. In speaking of the wires, I have avoided the terms positive and negative, because the positive is generally spoken of as the leading wire, and the negative as the return. That is to say, we speak as if the current flowed down the positive wire and up the negative. In practice, however, we join the positive pole of the dynamo to the ship's side, and the negative to the wire. "But if you do that you are charging up your ship with electricity!" I have had said to me. But it must be remembered that though it is very convenient to speak of electricity as if it flowed down the positive, it is only an analogy, and that we don't really know whether it flows at all. All we know is that if wires from the two poles are put into a solution of metal salts, the metal will be taken from the so-called positive wire and deposited on the negative. This is called electrolysis or electrolytic action, and it is on account of this phenomenon that we make the hull of the ship positive, otherwise it would be a matter of indifference which way we join them. Should any electrolytic action take place, owing to the presence of acidulated water, between a fitting or a wire and the ship's side, the tendency will be to take metal from the plate and deposit it on the wire or fittings. The amount of metal taken off the plate compared with its size will be insignificant, but if the action was reversed the amount taken off the wire might be sufficient to thin it down so much that it would get hot with its normal current.

The accompanying drawing, Figs. 3 and 4, show a plan and sectional elevation of the middle part of a ship with the position of the lamps leads and switchboards marked. S B stands for switchboard, and E L S indicates the electric lighting space, in which the engines, dynamos, and main switchboard are placed.

ELECTRICITY IN MINING, AS APPLIED BY THE ASPEN MINING AND SMELTING COMPANY.*

BY M. B. HOLT.

The Aspen Mining and Smelting Company, of Aspen, Pitkin Co., Colorado, was the first mining company in America to employ electrical power for hoisting. Early in the year 1888 the question of power for the development of the ore-horizon lying below the level of the tunnel through which the property is worked, became one of importance. The conditions under which it was proposed to use power were as follows: The company's mines lie upon the north-western slope of a mountain, the ascent of which is at an angle of 28deg. from the horizon. The ore, consisting of argentiferous galena and other silver-bearing mineral, is found at or near the plane of contact of a superincumbent mass of blue limestone, with an underlying bed of dolomite. This contact plane dips north 30deg. west, at an angle of 60deg. with the horizon.

A tunnel 1,000ft. in length, driven south into the mountain near its base, penetrates this ore-mass at a vertical depth of nearly 500ft., and through this the ore and the waste material are brought to the surface. For the purposes of drainage and transportation, the tunnel has received a grade of 3 per cent. towards its mouth, while from its breast or inner extremity level branches or drifts are run both to the right and left, following the strike of the ore-bearing plane, and developing it in its lateral extent. The development below the tunnel level was begun by sinking two inclines, which were intended to follow the ore-plane in its descent, and which, it was contemplated, might acquire considerable depth. One of these inclines began near the inner extremity of the tunnel, and the other was started 300ft. distant in the drift towards the north. Both descended below the tunnel level at an angle of 60deg. Power, applied to hoisting machinery of some kind, was necessary to bring up the ore and waste material from these inclines, and from the levels that would be driven in future.

The first plan considered was the use of steam power; that of compressed air was then discussed. Both of these plans were finally laid aside for weighty reasons, although the latter offered several advantages over the use of steam in the inside workings. It then occurred to Mr. Fred. G. Bulkley, the manager of the company, to duplicate the operations of the Compagnie de la Ferronière on a larger scale; to use electrical power, utilising, for the generation of the current, the power daily going to waste through the channels of mountain streams in the vicinity. Accordingly a flume was constructed, with ample capacity, giving an effective head of 63ft., and a 5ft. Pelton waterwheel, was selected as the motor. A 50-h.p. 500-volt constant-potential Edison dynamo was then set up and run under the direction of the Roaring Fork Electric Light and Power Company. This machine generated the current at a distance of 6,000ft. from the mouth of the tunnel.

After long delays and by constant importunity, attended with more than one failure, Mr. Bulkley finally secured the attention and aid of a manufacturer of electrical machinery to provide the hoisting plant for the mine, and finally, in July, 1888, the first electric hoister used in mining work in America was placed at the head of the Veteran Tunnel, and successfully used for hoisting from the incline near this point. The same motor, by engaging with a second drum, draws the empty cars in the tunnel by a tail-rope system, the loaded train running out by gravity. This hoist consists of a 7½-h.p. street car motor, manufactured by the Sprague Electric Railway and Motor Company. This motor proved the success of the plant from the start, notwithstanding the trying conditions under which it was at first used—one of which was the great amount of moisture in the workings, which condensed upon the machine. Later, the iron pinions on the armature shaft were exchanged for raw hide pinions, diminishing the noise when running, and also the liability of any leakage of current to the levers and other parts of the machinery. The working of this motor was so successful that during the same year a similar hoist was placed at the head of the incline, 300ft. to the north-east. each of these hoists was designed to raise 250 tons 250ft. up a 60deg. incline every 24 hours, estimating 16 hours of actual working time.

The first motor has been in constant use for hoisting for three years, during which time the cost of repairs has been as follows:

Replacing field-magnet coils	$43.00
Rewinding one armature	80.00
Replacing commutators	75.00
Total repairs	$198.00

This does not include the cost of commutator brushes which have to be replaced from time to time, which is, however, a small item. The first item of expense above given was necessitated by the burning out of the insulation on the wires of the magnet coils, which might have resulted from one or more of several causes. The second item was due to the bursting of the binding wires on the armature. This, had it been anticipated, might have been guarded against. The last item, caused by the wearing out of the commutators, was due to the natural wear between the commutator and the copper brushes which were originally employed.

Recently the company has put carbon bruh es upon all of the motors, and also uses them upon the dynamos. Since this change has been made, the motors have run without sparking, and the wear upon the commutators is inappreciable.

The company has an extra armature that can be used in either motor hoist, so that in case of accident very little time need be lost in repairing the damage. In the case of the accident to the field-magnet coils mentioned above, the burnt coils were replaced without much delay by others bought in Aspen. The total time lost, due to accidents or repairs, during the time the hoist has been in use amounts to 12 hours.

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* Paper read at the Glen Summit meeting of the American Institute of Mining Engineers.

In the latter part of the year 1889 the company, having available water power not in use, decided to have its own generating plant. Previous to this it had been supplied with power from the Roaring Fork Electric Light and Power Company. Work was soon begun, and by July, 1890, the company was generating its own power. This plant has a capacity of 100 e.h.p., which is generated by two 50-h.p. Thomson-Houston motor type dynamos, wound for a constant potential of 500 volts. These are run from two double Pelton waterwheels, 42in. in diameter — *i.e.*, four 42in. wheels, two being paired together on each shaft. Each of these four wheels is impelled by the force of the water issuing from two nozzles and applied to the wheels.

A pressure of about 35lb. per square inch., as indicated by a gauge at the foot of the main column pipe, is obtained from an effective fall of a little over 80ft. This fall is obtained by fluming for a distance of 1,300ft. The flume has a capacity of 1,000 cubic feet of water per minute.

The requirements calling for greater or less power are met by deflecting the nozzles, which work on a ball and socket joint, by means of a Woodward governor, set to maintain a constant speed of the waterwheel shaft from which it is actuated. The wheels are enclosed in an iron hood, 4ft. by 4ft., which can be taken off with little trouble, the joints being kept tight with rubber gaskets.

The adjoining ends of the waterwheel shafts carry a friction clutch, by means of which the shafts can be run as one shaft when it is desired to throw the output of both dynamos on one common line.

The electrical connections in the generating station are as simple as possible, the dynamos being connected with the switchboard by overhead wiring hung from the trusses.

Wiring.—The generating station is situated 6,000ft. from the entrance to the tunnel. The stationary motors now in use are situated at distances of 1,800ft., 2,200ft., and 1,000ft. from the entrance underground. From the power station to the tunnel the current is carried by bare 00 copper wire, except for about 300ft. at each end, where an underwriter's insulated wire of the same size is used. Inside the mine the current is carried to the two main hoisting stations at distances of 1,000ft. and 1,200ft. by kerite seven-strand conductors, having a heavy insulation $\frac{14}{32}$in. in diameter. Okonite or Grimshaw insulated wires are used on all the other circuits inside the mine, where the insulation must necessarily be of the best. On none of the circuits inside the mine is there a loss exceeding 5 per cent. Along the outside circuit there is at present, when the wires are carrying their maximum load, a loss of from 5 to 6 per cent.

Cost of Generating.—The cost of generating, as obtained by dividing the cost of labour and lubricants (interest and depreciation are not included) by the horse-power demanded, amounts at present to 0.00$\frac{3}{5}$dols. per horse-power per hour, and greater amounts of power could be furnished at a lower rate per horse power, as up to 100 h.p. no increase of plant would be necessary, the cost for labour would remain the same, and the cost of lubricants would advance but little.

In July, 1890, the company received from the Sullivan Diamond Prospecting Company, of Chicago, an electric diamond prospecting drill. This was the first drill of its kind, and was built for the company at the request of Mr. Fred. G. Bulkley, with the understanding that it should have a thorough trial, and be retained if satisfactory. It is operated by a 3-h.p. Thomson-Houston motor, and has a capacity of 400ft., taking out a core $\frac{15}{16}$in. in diameter. The drill was first set up on the surface, and experiments were made with it by drilling into an immense granite boulder. It was found that in this kind of rock it would drill 2in. per minute, taking out a core of the above diameter. It was then put into the mine, where it has been used steadily during the past 12 months for exploring the hanging and footwalls of the mineral deposit, which are respectively a hard blue and often silicified limestone and a brown dolomitic limestone. In these rocks the machine drills at the rate of 1½in. to 2in. per minute; or in a shift of eight hours, allowing for all delays essential to diamond drill work, the progress made varies from 6ft. to 32ft., depending upon the character of the rock. The average per shift, allowing for time lost in moving, setting up and drawing cores, is 15ft., one drill man and one helper being employed. About 4,400ft. have been drilled to date of writing, July 6th, 1891. The exact cost, including all expenses, has been 68 cents per foot. This is rather higher than was expected, and it is thought that it can be reduced.

Recently finding that the 7½-h.p. hoist at the head of one of the inclines was getting too small for the work required, it was removed to another part of the mine where it could be advantageously employed, and a 25-h.p. C. & C. electric motor put in its place. The larger motor is geared so as to raise a load of 3,000lb. up a 60deg. incline 275ft. per minute. It is capable, by actual timing, of making the round trip from a depth of 550ft., with a load of 3,000lb. in three minutes.

At the time of writing, the company is about to apply electrical power for running a small machine shop and its timber-room and carpenter shop. It is also proposed in the near future to employ an electrical locomotive for surface tramming.

A contract has been made with the Thomson-Van Depoele Electric Mining Company by which this company is soon to receive, upon trial, a Thomson-Van Depoele electric percussion drill, and a motor transformer for supplying the drill with a current of 220 volts from our 500-volt mains.

The main working galleries of the mine are lighted by electricity, the current for which is taken from the power mains, and five 100-volt incandescent lamps are connected up in series. As the light produced is found to be sufficient and the life of the lamp is thereby prolonged, six of these lamps are, in most cases, placed in series with each other. Eight h.p. of electrical energy is now employed for lighting purposes.

The recognised advantages of electrical power for mining purposes may be briefly summarised as follows:

1. It can be transmitted long distances with small loss, thus making it possible to use power at such a distance from its source as would render it otherwise unavailable, as in the case before us.
2. The conductors for conveying electrical power from one point to another require less space, are more easily put in place and repaired, are easily tapped for branch circuits, and form a more flexible system throughout than any other mode of transmission permits.
3. The electrical system is ideal, viewed from the standpoint of cleanliness.
4. The stations for utilising electrical power can be made to occupy a minimum space.
5. If this system does not assist ventilation, it does not, on the other hand, vitiate the air in the mine workings.

After three years' use under the varying conditions of mining work the electric current of 500 volts has proved itself free from danger to life, and has caused no inconvenience further than one or two severe shocks. Even the risk of receiving a shock has proved sufficient to suppress the spirit of investigation with which some men are endowed. The best illustration of the convenience and flexibility of the system is the diamond drill, where the conductors are unwound and strung up as the drill moves along, or taken down and coiled up, as may be desired.

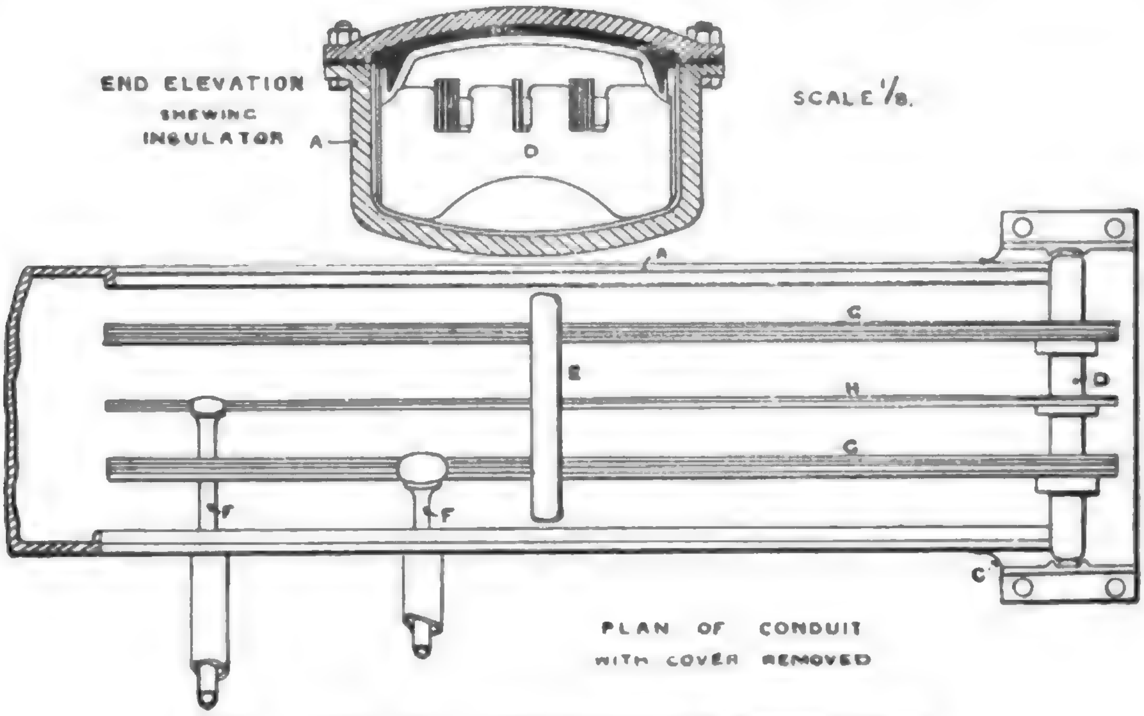
UNDERGROUND MAINS.—VIII.

MESSRS. LATIMER CLARK, MUIRHEAD, AND CO.'S SYSTEM.

The three-wire system of underground mains in iron conduits devised by Messrs. Latimer Clark, Muirhead, and Co., first used by the St. James and Pall Mall Company, is illustrated herewith. In this system the mains are formed of copper strips laid edgeways, carried upon porcelain insulators of special shape, the whole being laid in cast-iron conduits.

The number of copper strips used varies, being proportioned to the current which is to flow through. In the largest size, eight strips are fastened together with gunmetal clips. In the illustration, A shows the trough-shaped cast-iron box forming the conduit; they are made 3ft. or 6ft. long as desired. B B are loose cast-iron ends, also trough-shaped, which connect the lengths of conduit together; these are made of a loose fit, so as to allow of a slight set, and the actual joint is made by running lead into the groove shown at C. A cast-iron cover rests on a ledge inside the trough, and the joint is kept watertight by hemp and red lead packing.

The copper mains are carried upon porcelain bridges, D, of special shape, which rest on the bottom of the trough, but allow free passage for any water which may enter. For this purpose also the troughs are always laid with a slight slope towards the junction-boxes. To keep the mains in position, a saddle-shaped porcelain distance-piece, or "jockey," E, is dropped over the strips between each pair of porcelain bridges to prevent any chance of short-circuit.



Messrs. Latimer Clark, Muirhead and Co.'s Underground Mains.

The branch service mains to the houses consist of well-insulated cable, drawn into a wrought-iron pipe, and the pipe itself is screwed into a boss cast for this purpose on certain troughs, one of which is laid between each two houses along the street. In the figure the positive and negative mains are marked G, and the intermediate main H. The branch leads are secured to the mains by soldering. The separate strips of copper of which the mains are composed, are fastened together at intervals by gunmetal clips.

Junction-boxes are built at frequent intervals of brick, with cast-iron frame covers and stone centres. These junction-boxes are suitably drained, and, as above mentioned, the culvert, wherever possible, is laid with a fall to the junction-box. Wherever this is not possible—for instance, where a dip occurs and the culvert cannot be drained direct—a syphon-box and hydrant is fitted, so that any water that may collect can be pumped out in the manner that is customary with gas mains.

At the junction-boxes the copper mains can easily be disconnected for testing or for making connections. To do this while the current is on, the connection between two sections is first shunted by two copper clips, joined by an insulated flexible cable; the connection is then broken, and the service main joined to the severed cable, which is afterwards reconnected.

The mains are served by feeders, and from each feeder point pilot wires are brought back to the station, so that the potential can be regulated.

In all, about seven miles of mains have been laid by the St. James's and Pall Mall Company, and at the present moment supply is carried on for 37,000 lamps of 8 c.p. through these mains, and the number is being added to daily. The plant in running order amounts to 22,000 h.p., and a current of 10,000 amperes can be put on the mains. The copper in the mains is laid in two sizes only, ordinary mains having four square inches of copper (1·6, ·8, and 1·6) cross-section, and the branch mains of two square inches cross section. The feeder mains supplying the northern half of the district, which will ultimately be used as a trunk main between the two central stations, has a total cross-section of eight square inches of copper over the three conductors, and is probably the largest electric lighting main yet laid. The use of heavy copper mains and low-tension dynamos, it is claimed, have enabled the station to deliver a higher percentage of the current generated than is possible either with high-tension dynamos and transformers, or with low-tension system using accumulators. The district in which this system is employed is peculiarly suited to its employment, and both Messrs. Latimer Clark, Muirhead, and Co., the contractors, as well as the St. James's and Pall Mall Company and their energetic engineer, Mr. Sydney Dobson, must be congratulated on the success which is attending their efforts.

THREE-PHASE ALTERNATE-CURRENT MOTOR.

We have already referred to the work of Mr. C. E. L. Brown in connection with the three-phase system. The remaining part of the system—viz., the motor—has now to be considered, for we have previously described the dynamo and transformer.

Mr. Brown started his investigation with the intention of avoiding any sliding contacts with motors, as only in this way is it possible to approach the ideal apparatus for practical work. Mr. Brown took up the study of the multiphase current in the middle of last year. By means of this system he perceived a way to obtain a practical motor. At the same time it was reported that the Allgemeine Electricitäts Gesellschaft in Berlin had worked in this direction, and had obtained satisfactory results. In consequence, the Oerlikon Works put themselves in communication with this firm. The result was that both firms united to improved the multiphase system. In August last year a 2-h.p. motor, having no sliding contacts, was finished in Oerlikon after Mr. Brown's design. This motor must be regarded as the first real commercial multiphase motor constructed up to that date. In this motor for the first time a hole armature, in connection with Gramme winding, was employed in the multiphase system. In the first days of the same month Mr. Brown applied the hole armature in connection with drum winding to the 300-h.p. generator and motor designed for the Bülach-Oerlikon electric transmission, which plant, though probably not generally known, gave birth to the Frankfort-Lauffen experiment. One of these machines is working at present in Lauffen. The hole armature in this application offers many advantages, such as the possibility to reduce the magnetising current to a minimum. For this reason the Allgemeine Electricitäts Gesellschaft also adopted a similar design for their multiphase-current motors, as, for example, in the 100-h.p. motor in the exhibition.

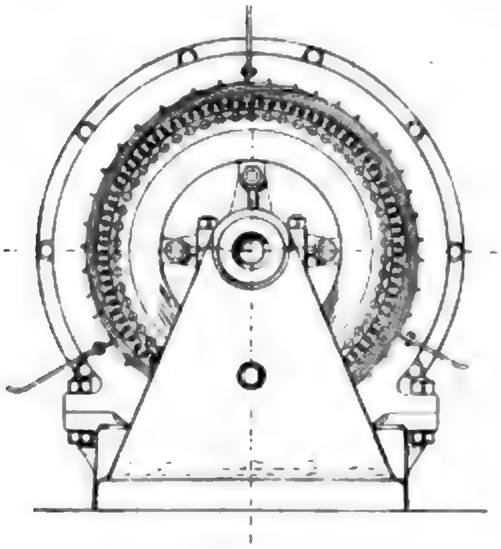


Fig. 1.

From the drawing herewith given of Mr. Brown's motor, it will be seen that the armature, Figs. 1 and 2, is stationary, and in the general arrangement quite similar to the above-mentioned 300-h.p. generator. In consequence of the smaller size, the armature contains more than three wires to each pole. The three armature circuits are connected similarly to a Thomson-Houston armature, and the winding is so arranged that there are produced four rotating poles. With 40 cycles the motor makes about 1,200 revolutions per minute. The normal pressure for the motor is 80 volts. A reduction to 50 or an increase to over 100 will not make a practical difference in the speed.

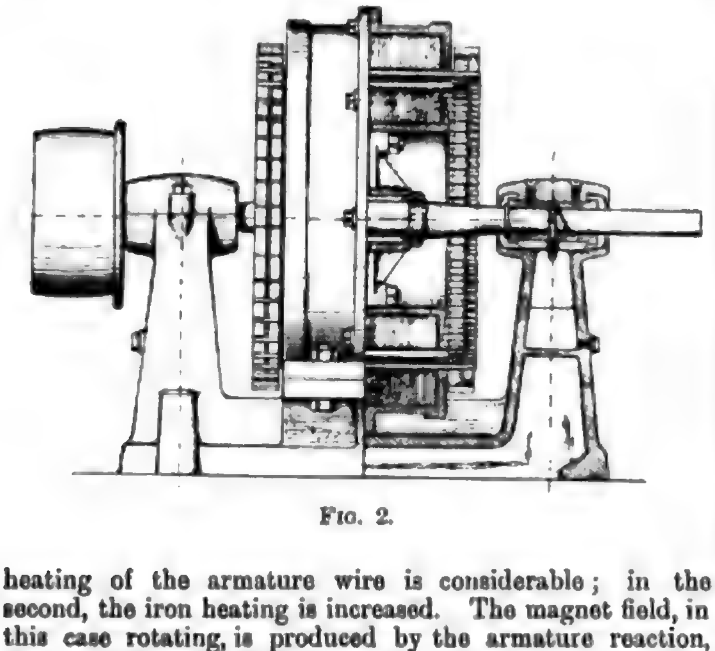


Fig. 2.

Of course, in the first case, the heating of the armature wire is considerable; in the second, the iron heating is increased. The magnet field, in this case rotating, is produced by the armature reaction, thus avoiding all sliding contacts. The magnet field is composed of a laminated ring with holes, in which are placed insulated copper bars. The free ends on both sides are connected by copper rings—this produces the whole field, and it is not easy to imagine a more simple construction. Before giving some results of the trials, some general figures relating to the motor may be of interest. The armature, Fig. 3, has 90 wires of about 40 mm.^{2} section; the mode of winding and connecting up is shown schematically in Fig. 4. The weight of copper is 20 kilogrammes, the weight of iron about 120 kilogrammes; the width of the armature is 200 mm., the outer diameter about 500. The rotating magnet carries 54 copper bars, with a section of 100 mm.^{2} The weight of the copper is 15 kilogrammes, that of the iron is 70 kilogrammes. Recent trials in Oerlikon with this motor showed that it can easily supply 20 h.p. The heating even with a continuous run is low, as no part of the motor showed a higher temperature than 20deg. to 25deg. C. above the temperature of the testroom. It may be of interest to mention that the rotating part shows practically no heating. The difference of speed between no load and full load is only about 3 per cent. The torque of the motor at starting is large. It could easily put in motion a 25-h.p. ventilator. The same was the case with an extra-excited dynamo which was working on a 20-h.p. absorbing resistance. Over 200 kilogrammes torque could be obtained on the 20 centimetre pulley. The motor can carry also a considerable overload, and runs without the least noise.

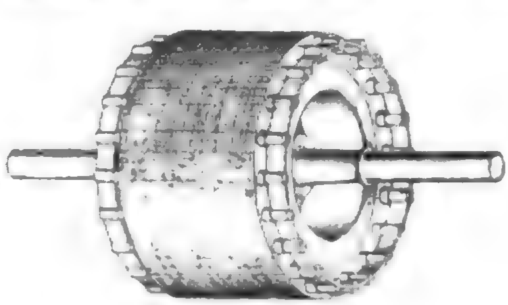


Fig. 3.

The starting of the motor is similar to a continuous-current motor controlled by a resistance in series with the armature circuit. Regarding the commercial efficiency, no accurate tests have been completed. The losses are about the following: In armature copper and iron they amount to about 4 per cent.; in the magnet copper and iron, including friction, to 4 per cent. From these results an efficiency of 92 per cent. is obtained A commercial efficiency of 90 per cent. can be taken as certain. That the losses are very small is further shown by the very moderate heating, in spite of the small size of the motor and the want of efficient ventilation. A further advantage is that the commercial efficiency remains a high one, even if it works considerably overloaded.

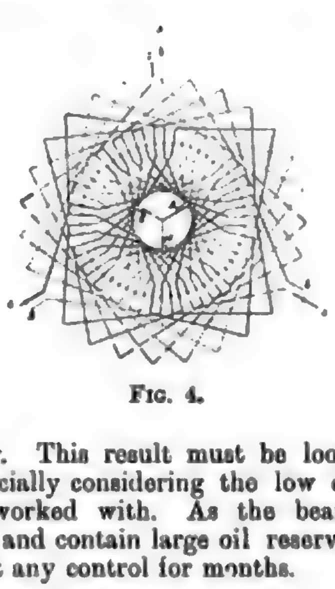


Fig. 4.

The weight of the motor is 420 kilogrammes, or a trifle over 20 kilogrammes per horse-power. For locomotive purposes it would not give the least difficulty and influence on the solidity of the design to reduce the weight to 300 kilogrammes, the result of which would be only 15 kilogrammes per horse-power. This result must be looked as a very good one, especially considering the low current density the motor is worked with. As the bearings are automatically oiled, and contain large oil reservoirs, this motor can run without any control for months.

What is Electricity?—See *Science Siftings*—No. 1 page 12—and for ever after hide your heads. This is a progressive age. If *Science Siftings* is to be believed we are progressing—backwards.

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ENCORE OKONITE.

The attention devoted to the Okonite Company has not resulted in its vindication. A slashing onslaught, in the issues of Monday and Tuesday, has been made against it in the columns of our financial contemporary the *Oracle*. If ever a company was in a bad way it is the Okonite, and the sooner the shareholders institute a rigid investigation of all that concerns their property, the sooner they will save some remnant of their money. Since the appearance of our article last week, a copy of the original prospectus of the company has been handed to us. This prospectus will not bear much investigation in the light of recent events. A clause in the prospectus reads: "The two businesses will be taken over as going concerns from 1st January, 1890, from which date the profits made will be for the benefit of the company." In considering this clause it must be remembered that the company was not floated till July, 1890, and the prospectus has the following estimated future profits :

Profits for the period ending 1st July, 1891.

Profits already earned . . . and accruing to this company . . .	£17,113
Profits already earned . . . and accruing to this company . . .	3,000
	£20,113

These profits were earned respectively in America and in England, and, as has been said, most readers of the prospectus looked upon this £20,000 as utilisable for dividends. However, they have now found out their mistake. The framers of the prospectus, in the exuberance of their spirits, estimated the profits for the succeeding twelve months not at the same rate as during the six months of which the profits were known, and so the estimate, instead of doubling the profits for the double period, giving a probable £40,226, runs the amount up to £56,390 for the first year of the company's business, to £80,000 for the second year, and still more for the third. We are very much inclined to think the Courts would hold the prospectus to be fraudulent, and that shareholders, if they desire it, will be able to recover their money from the directors. Upon the face of it, the prospectus is very hazy. The businesses were bought as from January 1, and therefore we contend, whatever may be said to the contrary, were purchased for a sum according to the valuation on that day, and no other reading of the clause in the prospectus will prove it otherwise. The purchase price was £324,990, all debts being paid and received up to the 1st January. How, then, can the profits from January 1st to July 1st be included in the purchase-money? The balance-sheet assumes that the businesses were bought as valued on the 24th June, because the agreement was made on that day. Prospective profits were not valued in on January 1st. The price paid therefore was £324,990, and as the value of the plant, machinery, and stock-in-trade was £107,733, the enormous sum of £217,257 was paid for goodwill—and promotion. If this little nest-egg was divided equally between original vendors and promoter vendors, it would give them over £100,000 apiece. The addition of £217,257 to the requisite capital is watering with a vengeance. Then again the prospectus speaks of the "business" as "in full operation," gives no hints of extensive outlays to be immediately undertaken, and yet within twelve months of the floating of the company it is admitted that a sum of £55,615 has been spent in acquiring land and increasing machinery, etc. The prospectus takes credit for an available working balance of £110,000. Half the working capital has gone in these extensions. Further, as we showed last week, according to the valuation of the balance-sheet, another £71,459 has gone in increasing stock. No matter how you look at this company, it has no real working capital, and its available liquid assets are insufficient to pay its creditors. It can only get money to pay dividends by getting rid of stock. In America, okonite-covered wire sells to a limited extent. In England, the sale is very limited indeed. As the chairman is reported to have said, the cable companies won't touch okonite: they believe in guttapercha. The electric light companies won't touch it because it is too dear. Then who on earth will buy it to the extent necessary to provide dividends in this gigantic concern? Take away that curse, watered capital, and the concern is undoubtedly sound; with the watered capital we venture to predict we shall soon hear the last of the Okonite Company. This is not the only company whose proceedings we intend to keep well before the public gaze, and in other cases, as in this, we shall have the aid of the financial papers. It is a cruel thing for an industry when promoters can float companies with a capital out of all proportion to the real value of the concern. It may be assumed from the balance-sheet that okonite was boomed to sell. The prospectus gives profits in

American business alone for year ending	Dec., '87	£7,752	18	7
,, ,, ,, ,,	Dec., '88	10,558	3	10
,, ,, ,, ,,	Dec., '89	23,895	8	5
,, ,, estimated ,,	Dec., '90	41,237	2	3

The English business made £4,000 profit in 1889, and was estimated to make profits of £6,000 in 1890.

The total actual profits for twelve months (except one month for American returns) after the company took over the business was only a paltry £26,151. 7s. 10d. What a dreadful falling off. Have the customers deserted them? There is the promise, where is the performance? Be it recollected that the profits for the half-year after the businesses were purchased by the company to the time the company took charge, are said to be £21,711, nearly as much as in the next twelve months. That will do for the present. Perhaps someone acquainted with the whole facts will kindly controvert our statements and figures. We may ask these questions in addition: Who made the valuation of stock for the purposes of the balance-sheet? Upon what basis was this valuation made? Readers, we conclude with one more extract from the prospectus: "The remarkable and rapid progress of that company (the Okonite Company of New York — one of those purchased) has placed it among the most solid industrial undertakings of America." Go to the Crystal Palace, and see that firework commonly called a rocket. Behold it soareth upwards rapidly and triumphantly, like the Okonite Company aforesaid; it reaches its maximum height, the propelling power is expended, and lo, it falleth as rapidly as it heretofore ascended, till it is lost in darkness and obscurity.

THE CRYSTAL PALACE.

Ten years or so ago an exhibition at the Crystal Palace followed swiftly on one at Paris. The latter had opened out a new era. Till its advent the dynamo and the incandescent lamp were little understood. The possibilities of electric lighting were concentrated in the arc lamp, and the much-talked-of "division of the light." The Paris Exhibition, and especially the Swan exhibit, opened the eyes of electricians to the fact that arc lighting must, so far as interior work was concerned, give place to incandescent lighting. The Crystal Palace Exhibition drove home the moral, and since then the construction of the dynamo has been considerably modified, and incandescent lighting has become the most important factor in this branch of industrial work. Ten years is not a long period of time, yet it has been sufficient to witness a convulsion in the industry almost blotting it out of existence—a financial boom followed by a financial gloom. Gradually, however—thanks, principally, to shiplighting—the struggling firms gained footing, good work paved the way to public belief in the new illuminant, the gloom passed away, and there has come a period of increasing activity. Meanwhile, other developments of electrical applications are claiming attention. In America electric traction has gone ahead, and soon seems destined to be used upon the majority of tram lines, generally known across the Atlantic as street railways. In England electric traction has had an uphill fight. The conditions are very different, yet it ought to have made greater progress. Volk, at Brighton, built the first English line, and though at one time or another this line has been subjected to disasters from the elements and financial difficulties, it is still very much to the fore at Brighton, and we believe Mr. Volk has been enabled to once more personally take charge of the line. The praises of Mr. Volk have not been sung by newspapers like the praises of Edison, but that is because English newspapers in ninety-nine cases out of a hundred neglect to find out what is done under their nose in order to belaud a foreigner whose word they take and whose work is ancient Chaldaic to them. You never find the great London dailies inserting a paragraph about Crompton, Kapp, Mordey, Esson, Hopkinson, Ferranti, Parker, or one of a score of others who might be named, because they reside and do their work among us; but hardly a week passes without it being dinned into us that someone in France, Germany, or America has discovered something wonderful.

But what has all this to do with the Crystal Palace? Another electrical exhibition is to be held therein, to open at the beginning of the new year. It is said that over 200 applications for space have been made, and presumably the majority of these applications have been made by Englishmen. If, as we trust they will, the exhibits are truly representative of the industry in England, we foretell that in no other country in the world, except perhaps in America, could so great a variety and so admirably designed and executed machines be sent to an exhibition. The display at the Crystal Palace offers an opportunity for English makers to assert their general superiority, and to show the world that in no single electrical department can they be approached, much less surpassed. Here and there, in other countries, are firms of the highest repute; but in England we have a large number of manufacturers, any one of whom could make an exhibit that would worthily represent the country. If it is worth holding an exhibition at all, it is worth while striving by every means to make that exhibition a success.

Last Saturday the foundation-stone of a central station was laid (under the auspices of the Electric Installation and Maintenance Company, and the contractors, Messrs. J. E. H. Gordon and Co.) by Colonel Loyd. The work at this station is to be hurried on in order to supply current to those who require it at the forthcoming exhibition. Subsequently the station will supply light for the district. Every effort is being made by the Palace authorities to induce manufacturers to exhibit to advantage, and we are quite sure the technical journals, whatever the dailies may do, will describe the exhibits as faithfully and as lengthily as is necessary. The Crystal Palace has a history unique in exhibitions. It was built for the first Great Exhibition. Under its roof a number of exhibitions have been held. Its management is therefore used to supply the requirements, and know exactly what is wanted. Its situation makes it fairly easy of access, the train service is by no means bad, and it offers many inducements to visitors in addition to the exhibition—hence may be supposed to be more attractive than would another building devoted only to the purpose of the exhibition.

The history of many exhibitions would have to contain a chapter solely devoted to procrastination, instability of mind, and regrets. Many a manufacturer first thinks he will exhibit, then that he won't, and so puts off the application for space till too late. Then during the existence of the exhibition and ever after he regrets not having exhibited. Others regret having exhibited in a half-hearted manner. No exhibition of repute passes without making the reputation of some firm and laying the foundation its fortune. Over and over again has this been seen. An unknown firm makes a taking exhibit, gets known, obtains new clients, and opens up good business. Exhibiting does not pay when done in a half-hearted manner, but, like advertising, it pays when properly engineered. We trust, then, that the forthcoming exhibition may be worthy of the place in which it is held, of the individual exhibitors, and of the country generally.

SUBMARINE CABLES IN WAR TIME.

Sir Samuel Baker, in an article to the *Daily Graphic* of last Saturday on routes to India and the East, points a moral to his tale by supposing a war with France. He assumes conditions, in the first place, existing as at present, and in the second that we have left Egypt, Malta, and Gibraltar. He holds that under existing conditions the control of coaling stations means supremacy at sea. But the general drift of this article is outside our special subject. However, Sir Samuel touches upon "Cables," which matter is germane to our columns. He says that what would happen in the event of war would be that, "In a few hours all the submarine cables would be cut, and we should be bereft of telegraphic news from the outside world." With all due deference to Sir Samuel Baker's knowledge of the subject, we cannot accept his dictum as regards cables. His views need corroboration before they can be accepted in this particular. He seems to infer that in case of a war with France the French ships would be able to destroy all cables. It is difficult to imagine how this could happen, even with Russia allied to France. It is admitted that we should be paramount in the Indian Ocean, and it must not be forgotten that cables now run on both sides of Africa. A dash through the Straits of Gibraltar, or from the Channel, might allow a French vessel to cut the cable, but the delay arising from such breakage would be reckoned by a few hours. It may at once be admitted that the links of the Eastern Company through France, and their cables in the Mediterranean, might be rendered useless, though it is doubtful if all the links could be severed. The proposed Pacific cable would give another and a less easily tampered with telegraphic route to the East. Altogether, a closer study of the question should show that cables cut at one or half-a-dozen points will by no means prevent communication. It is not an easy matter to grapple in deep waters, and if the cables are cut in shallow water, properly arranged vessels will pick up and send messages through the exposed ends. Is it positively certain, again, that precautions have not been taken in some instances? and that should an attempt be made to break a cable, a privately laid loop may enable communications to pass without any trouble whatsoever. Before, however, absolute proof against the contention of Sir Samuel Baker can be given we must know what cables would probably be cut, and at what points. The various alternative methods of overcoming the difficulties can then be shown and explained.

LITERATURE.

Spacial and Atomic Energy. Part II. : Heat. By FREDERICK MAJOR. Eyre and Spottiswoode.

It is enough to drive any reader from a book which has such sentences upon the first page as: "The mathematical sustension of a particular rendering of effects resulting from one manifestation of Nature's force has established a particular form of mechanical reasoning applicable to effects resulting from gravitation—regarded as independent power—but not to power from which it and other phases of energy emanate." Further on we find: "The characteristic of an 'electric state' is that a body is at recurring times continuously dilated with particular constituents of general interstical fluids in one direction more than in others—therefore, with reverse effects in other directions where, according to influences of other bodies about it, it continuously loses such constituents." In other words, the author imagines a flow, or fluid, or ether, or something analogous to the usual imaginary lines of force. There is nothing, however, in this book to prove his convention better or even as good as the ordinary convention; it is, in fact, almost entirely speculative meandering away into the blue empyrean without any attempt to harness the vague generations to the use of practical calculations. It is one of the finest attempts of how not to do it, with which modern literature is acquainted. New suggestions should not be promulgated unless they render more easy the calculations relating to practical work or lead to more perfect results. At the present time we can understand Prof. Tyndall, but find Mr. Major incomprehensible. The fault no doubt is due to malformation of brain structure, and is our misfortune. Till a remedy is found for such a mental failing, we must recommend others to study Prof. Tyndall in preference to Mr. Major.

FORTY-EIGHT THOUSAND VOLTS.

There is little doubt that good results will ensue through the holding of the Frankfort International Electrical Exhibition, which terminated on Monday evening, after being open for just over five months. Many people are of opinion that exhibitions are of little value, whilst others hold the opposite view; but we imagine that all will agree with us in stating that the exhibition in question has demonstrated the practicability of utilising very high-tension current for the long-distance transmission of electrical energy.

At midday on Monday a "Festsitzung," or luncheon, took place, when complimentary addresses were given concerning the success of the exhibition and its industrial importance by Mr. Leopold Sonnemann (chairman of the presidential committee), by Prof. von Helmholtz, Dr. von Miguel (the German Minister of Finance), by Mr. Adickes (honorary president), and by various others. This brought the formal proceedings to an end, but the doors of the exhibition were only closed at 11 p.m.

As our readers are already aware, the Frankfort Exhibition has been made the meeting-place of various learned societies, German municipal authorities, of representatives of the Glasgow and Dublin Town Councils, and of various other public and private bodies. The different applications of electricity have been fully shown, and the object of the exhibition—namely, the rendering popular of such applications—has been amply attained. The most important event has naturally been the electrical transmission of power from Lauffen, on the Neckar, to the exhibition, a distance of about 108 miles. The pressure of the current used was about 20,000 volts, a potential which had never previously been employed for practical purposes, and the success from a working point of view has been so remarkable that others have been stimulated to similar efforts. Messrs. Siemens and Halske, for instance, were not desirous of being outstripped by the Allgemeine Electricitäts Gesellschaft and the Oerlikon Maschinenfabrick, who carried out the Lauffen-Franktort installation, and for this purpose the first-mentioned invited on Saturday evening last, 17th inst., a select assembly to witness experiments with current at 40,000 volts. Electrical energy at this enormous potential was provided by means of two oil transformers, with the secondary windings placed in series, and the current was used to feed 400 incandescent lamps arranged in series. Previous to the switching on to the lamps, tests were made as in the case of the Lauffen plant; one experiment being made up to as much as 48,000 volts! The whole of the tests were satisfactory, and the lamps gave a steady light.

By these experiments and the success of the 20,000-volt plant, a great future is undoubtedly opened up for the utilisation of electrical energy for transmission over considerable distances for various purposes, and if in only this instance, the Frankfort Exhibition may be regarded as having been signally successful.

NEW INSTALLATIONS AT MESSRS. ARTHUR AND CO.'S WORKS, GLASGOW, AND ELSEWHERE.

The new works which have recently been erected by Messrs. Arthur and Co., of Glasgow, at William-street, Anderston, have been lighted throughout by electric light, the whole of the electrical work having been carried out by Messrs. Ernest Scott and Mountain, Limited, electrical and general engineers, Close Works, Newcastle-on-Tyne, under the superintendence and to the specification of Mr. W. A. Bryson, consulting electrical engineer, Glasgow. The present plant consists of two Tyne compound-wound dynamos, each machine being capable of giving an output of 25,200 watts when running at a speed of 670 revolutions per minute, and therefore easily capable of feeding 400 16-c.p. incandescent lamps each, but in case of emergency either dynamo is capable of running up to a maximum of 600 lights each. The current from the dynamos is taken to a very massive switchboard, consisting of two large enamelled slate bases placed one above the other. On the lower slate base two coupling switches are placed, arranged so that the dynamos can be coupled in parallel or run singly if required. Two ampere-meters are also provided for measuring the current flowing from each machine, and two voltmeters of the Cardew pattern for reading the pressure. On the upper enamelled slate base five double-pole main switches are fixed together, with five automatic cut-outs. These switches control the five floors of the building by separate circuits, so that any floor can be switched off from the dynamo-room. There are altogether 600 16-c.p. incandescent lamps. These are suspended from the ceiling throughout by flexible pendants, each pendant being fitted with a china ceiling rose, containing a fusible cut-out and a 10in. enamelled iron shade. The installation was officially started on Monday, October 13, Messrs. Arthur and Co.'s representatives and Mr. Bryson being present. The dynamos ran very satisfactorily, and the whole installation was pronounced a decided success.

We understand that Messrs. Ernest Scott and Mountain, Limited, are extremely busy at the present time in their electrical department, and have in hand the lighting of Messrs. Jones Bros. and Co.'s weaving-shed at the Bedford Leigh New Mills, Bedford Leigh, near Manchester. This installation is precisely the same size as the one at Messrs. Arthur and Co.'s, and they have recently supplied the lighting for the Dunston flour mill for the Co-operative Wholesale Society, Newcastle-on-Tyne.

Amongst new work we understand they have in hand the lighting of the Fustian Machine Cutting Company's new mill in Manchester, where they are supplying two dynamos each capable of running up to 1,000 16-c.p. lamps. They are also lighting the Bolton Technical School, H.M.S. "Retribution," Messrs. Hood, Haggie, and Son's works at Willington-on-Tyne, and have just made a contract for the lighting of a large training establishment at Newmarket for Lord Ellesmere.

Aberystwith.—At a meeting of the Town Council last Tuesday, it was decided to convene a special meeting to pass a resolution in favour of applying for a provisional order.

A NEW CENTRAL STATION.

On Saturday last, at the invitation of the Electric Construction and Maintenance Company, a number of guests assembled to witness the laying of the foundation-stone of the new central station at Wells-road, Sydenham. The district around the Crystal Palace is one that promises well for business, so far as lighting is concerned, though there may not be a large demand for power. At the present time it will only be necessary to describe the proceedings of Saturday, leaving for the future the description of the work as it progresses. The station, as designed, will in the first place receive engines of about 1,000 h.p., which will drive Wolverhampton dynamos. It is intended to complete the station in time for the opening of the Crystal Palace exhibition, and will first of all supply current for use during the exhibition. While current is so being used the mains necessary for distributing the energy in the district will be laid and the houses wired, so that the light can be obtained about the time of closing the exhibition. It will be seen from the report of the London County Council that due application has been made for laying these mains, and that the application has been granted. But to the work of Saturday. The guests arriving at Upper Sydenham, wended their way to the site of the central station at Springfield. The streets were made lively with the traffic, and the inhabitants of the houses round about turned out to see and be seen. A platform had been erected and bedecked with flags. Had it not been for the foresight in providing a platform most of the guests would have learnt practically the definition of mud, for the weather during the preceding week had not been favourable. If, however, the augury of bright sunshine is worth anything, this station ought to be successful, for the ceremony on Saturday was attended by glimpses of the luminary now so seldom seen in England. "Happy is the work that the sun shines on," was the text of at least one of the short speeches. After the usual formalities, the foundation-stone of the central station was duly and truly laid by the chairman of the company, Colonel Vivian Loyd. The stone has inscribed upon it, "This foundation-stone of the Electric Generating Station, constructed for the Electric Installation and Maintenance Company, Limited, was laid by Colonel Lewis Vivian Loyd, D.L., J.P., on Saturday, 17th October, 1891."

Previous to the actual laying of the stone, the Rev. A. E. KING, M.A., vicar of St. Philip's, Upper Sydenham, offered a prayer, and Mr. J. E. H. GORDON explained the plans of the company. Music was not forgotten, and a variety of airs were played by the band, concluding, when the ceremony of laying the stone was over, with the National Anthem. The visitors afterwards adjourned to the Crystal Palace, where they were entertained by the Electric Installation Company and the contractors (Messrs. J. E. H. Gordon and Co.). The toasts proposed and replied to were, after the time-honoured one of "The Queen and Royal Family,"

"The Army, Navy, and Auxiliary Forces," for whom General COOK responded.

"Success to the Electric Installation Company" was proposed by Mr. J. E. H. GORDON, who entered at greater length in his speech on this occasion than at the previous ceremony, as to the aims of the company. He explained that the station is situated at Springfield, Upper Sydenham, about 1¼ miles from the Crystal Palace, and will contain machinery for about 20,000 lights, with provision for extension. On January 1 a large electrical exhibition will be opened at the Crystal Palace, which will be of considerably more importance than the exhibition which has attracted so much attention at Frankfort. Contracts have been entered into under which the whole of the power of the new station will be supplied in the first instance to the Crystal Palace, and there will also be transmission exceeding that of the Lauffen at Frankfort, and sold to the exhibitors for motive and lighting purposes. During the exhibition mains will be laid through the whole area of supply ready for customers when the exhibition closes in the spring. There has been great controversy as to the relative advantages of the alternating high-pressure system, and the direct-current low-pressure system. The one gives greater facilities for transmitting current economically to a distance, the other has the advantage that it can be used economically for motive power and in conjunction with storage batteries. The inhabitants of Sydenham will have the advantage of both systems, as the new motor transformer system is to be adopted, which combines the advantages of the high-pressure alternating system, as far as regards transmission to a distance, with those attendant on the direct current, with its adaptability to motors and storage batteries. The contractors received the order to carry out the works at the end of August. The buildings were commenced on 16th September, and will be roofed in in about another fortnight. The whole of the electrical and steam plant is ready, and will be delivered as soon as the buildings are prepared to receive it. No difficulty is anticipated in getting the station running by 1st January.

Colonel VIVIAN LOYD replied on behalf of the company, and then proposed "The Crystal Palace Company," to which Mr. RAIT, deputy-chairman of the Palace, replied, and made allusions to the last electrical exhibition as well as to the forthcoming one. He put the matter plainly and bluntly, as a business man to business men, that the aim of the Crystal Palace was to earn and to save money. Colonel GARNAUD made a humourous speech in reply to "The Visitors." The toast-list was exhausted with the toast of "The Chairman," which, however, really came early, as Colonel Loyd had to catch a train.

Altogether we must congratulate the company and the contractors upon the excellent manner in which they decided to bring their work under notice, and we trust the ultimate success of the undertaking will be as great as that on Saturday.

SOME DETAILS OF THE CARE AND MANAGEMENT OF AN ARC LIGHTING SYSTEM AS PRACTISED IN THE MUNICIPAL OF ST. LOUIS.*

BY JAMES I. AYER.

(Concluded from page 378.)

As stated in the paper, the average number of lamps per trimmer, with a vehicle, is 68. When one stops and thinks about the work, where lamps are located close together, of easy access, supported by methods which enable the trimmer to get quickly at the lamp, or even supported, as mine are, when they are placed so high above the streets, that looks like a small number, because we have, as doubtless many others have, some trimmers who care for more than 100 commercial lamps per day. But we have got our lamps at this high altitude, and it takes a long time to raise or lower them. We are compelled to use a device for raising and lowering—a device which has to be lowered and locked in order to prevent its being meddled with, and that necessitates each time the unlocking of the device by the trimmer, applying the crank, lowering and raising the lamp; and as the poles are set on the kerb line of the streets, and passing vehicles could knock the device off easily, the hoisting device has to be placed up high out of reach of the sides of the waggons, and that necessitates the use of a ladder by the men to get up to the hoisting device. It seemed to me before we went into operation that it would be essential that we should have something of that sort. We have a cart, modified to suit the requirements, and enabling our trimmers to carry extra globes, extra lamps, rubber clothing, means for keeping the carbons dry, and any number of tools that they wish (and we require them always to carry a few) and to carry the means to enable the trimmer to make any temporary repairs for the purpose of removing any defect or trouble which he may find. We have found that by furnishing our men with cart and horse (requiring them to furnish the horses), we have been able to employ men for 65dols. per month who are in every way equal to the men whom we employ for trimming commercial lamps, where they carry a stepladder around the town, at 2dols. per day. For 65dols. per month we find them seeking the positions as trimmers. They furnish their own horses, feeding, shoeing, and caring for them in every particular, leaving us only to supply them with vehicles and harness. The cost of maintenance for vehicles and harness is not very great. The cost of outfit was about 75dols. per trimmer. The cost of repairs and depreciation of harness and vehicle is about 40 per cent. annually, as we calculate it. That is, it will cost about 40 per cent. of the investment to keep it up. That thing has been discussed somewhat, and in some other places they have tried the use of carts, and are not altogether pleased with them, but where the conditions are satisfactory, I must say that we find much better results in the care of our lamps in that way than we have ever experienced with the same class of help. With 40dol. trimmers, such as we have, I doubt if we could get the results that we do in any other manner. We have got a very useful little blank which I presume may be advantageously used in many other places. We have printed on it a form of telegraph pole with 15 cross-arms on it and 10 pins. Although we use no more than eight pins for our work yet we use whole lines in carrying our wires over the city, and we keep a record of every pole and wire on those blanks. The location of the pole and the positions of the wires on the pole is indicated on the blank. From the corner of First to Tenth street circuit No. 5 will occupy the two outside pins on the top cross-bar, and the side of the street and the name of the street is given, so that by reference to that diagram at any time we know the exact location of our own and of other people's wires. In laying out new circuits and in doing addition work it is a very convenient thing to refer to, and it saves lots of work. It is very convenient where you have many poles, and especially where you have to run a mixed line and interchange with other companies, to have some such arrangement. In the care of a station, it is rarely the practice in the smaller stations to have anything in the way of instruments except those furnished by the parent company, and possibly sometimes one outside instrument. We all know the utter unreliability of the ordinary commercial device furnished to us as an ammeter by these parent companies, and unless you do accurately know the amount of current, leaks will creep into the plant, which I am sure would astonish anyone if they were to go at the matter carefully and measure them. I do not think that there is a station in a town of 20,000 inhabitants and over that can afford not to be provided with a high-reading voltmeter (I am now speaking exclusively of, and referring only to, arc line circuits that will measure the whole difference of potential on your circuits during the operation of them, so that you may know the amount of energy being consumed, and accurate ammeters are essential in order to know what that energy is. In the paper I have made a point of that. I will give you a statement of a little test. Until I had made the test and made the comparison I could not realise that the difference or the opportunity for difference was so great. With 10 lamps adjusted to burn an average of 46 volts with 9·5 amperes of current, the average number of watts of the 10 lamps was 436 per lamp. Now, without changing the adjustment of the lamps in any manner, but simply increasing the current so that the ammeter needle read 9·8 amperes (an increase of 0·3 ampere, and you will find that the indicator furnished by our parent companies will not agree within half an ampere), with an increase of current of only 0·3 of an ampere the average consumption or increase of watts was 524, or an increase of 20 per cent. in the watts consumed. That was the result of changing only 0·3 of an ampere. When the current was increased so as to give the lamps 10 amperes, we had an average voltage of 58 volts per lamp instead of 46, an average of 550 watts per lamp, or an increase of 33 per cent. in the energy consumed. There is a saving equivalent to a very handsome profit on your lamps. We all know that often in a moderate-sized station someone will often come in and think the lamps are not in good order and ask "What is the matter with the lamps? Push them up." The ammeter is found to be all right, but still we give them more energy. Many of our superintendents want to have good lamps and they want to make a good show with them, and so they keep their lamps bright in this manner. Now they will get just as satisfactory a light and a more even light, by having the lamps properly adjusted and running them on a normal current, than they can possibly get in this manner, and be able to save from 33 to 50 per cent. of the energy consumed in those lamps. This is a point that I know a good many of you have already looked into, and you have discovered in practice that it is an opportunity for very serious leaks, but I have never heard anyone bring it out before. The matter has never to my knowledge yet been before the convention or publicly commented upon. This shows you the necessity of having a good and accurate instrument adapted to your work. Our practice is to take the commercial instruments furnished by the company whose apparatus we use, and then standardise them, regardless of their scale indicating where the needle should stand to indicate the currents that our lamps are adjusted for. We use two Weston ammeters as standard instruments. I find it desirable to have two rather than one. Those we use almost entirely for standardising these other instruments which we use in practice. There is something very peculiar about an ammeter. I find that they will run along perfectly accurate, and that two or three instruments will agree exactly for a week or 10 days, and then without any apparent cause, and when working under identically the same conditions, and collected together in series so as to take the same amount of current, the needle will vary sometimes as much as 0·2 or 0·3 on one instrument. Then we bring in our standard instrument and put it in the series in order to find out which one of those has changed its adjustment. It is something that we do not attempt to account for, grouped as they are, for this occurs in cases where we have them fastened to a board against a post, and where all the influences surrounding them are the same under all conditions and at all times, and they are not in close proximity to any wires carrying heavy currents, and there is no opportunity that I know of for change either in condition or position. And yet the change does occur. I think that money expended for good instruments to be used in adjusting lamps and in maintaining the current constant is money well expended. In operating the large number of lamps that we do, if we had an ammeter on every circuit (as some do) we would have a very variable condition of affairs. Of course, these variations in ammeters would exist. We keep continually two ammeters in series. We have a very convenient plug and socket made for inserting the ammeter quickly in the circuit, so as to get it right in circuit. It is placed on the switchboard by simply inserting a single plug. Thus, we connect the ammeter in series with the circuit. Our practice is in starting up as soon as the dynamo is in operation, to insert the plug, and see that the current is what we desire to show by this instrument. We go through the whole series in that way, and that thing is repeated in our station every two hours during the night, and during the daytime once an hour. We find it desirable to do this. While we have not much change in load we have changes in circuit conditions during the night, and the governors are not always responsive to a moderate change of load. You can easily build up your current 0·1, 0·2, or 0·3 of an ampere, and the governor will not always respond. We burn more carbon and, of course, more coal during that time. This matter of circuit connection is often a fruitful source of trouble as well as one of the causes of an immense loss of energy, and is a thing that we all ought to pay close attention to. I know that all central station men now make it a practice to make a solid circuit by making good line joints, but when we let out a lamp we are very apt to have a binding post there, and we are apt to insert the wire in either—in the hanger-board or on the lamp proper—and the man sets up the set-screw and leaves the lamp hanging there, and then the wire will corrode, and a condition will be brought about which will soon so disarrange things that a 40-light dynamo will run only 30 lights. We use hanger-boards for suspending all our lamps, whether inside in commercial use or outside in city use. The hanger-boards are all provided with cut-offs. But before the boards were put in service—not before they were put in service, for we put our plant in operation very hurriedly—and so we took our boards as they came from the manu facturer—but shortly subsequent to that we soldered a short section of flexible insulated cable to the binding post of each hanger-board, and then when the man comes along to make a line connection after the hanger-board is put in place, he makes an ordinary line joint. Thus they get a good strong connection. The soldering that is done is done in our repair shop, or done at the station, where they have time to have it done well. Of course a man cannot do a good job out in the wind, and under all the conditions usually existing when he has to solder up a connection of that nature, and where an iron is obliged to be used to solder a wire to a binding post. We have all seen cases where cut-outs on a line have soldered joints which had better have been left alone, and even the solder left off. There is often a lot of acid left on so that the wire is corroded in a very brief time, or they get a little lump of solder piled in one corner. The same practice obtains as to all the devices that we put in circuit. In cut-out boxes we use the best flexible insulated cable, so that it may be put in and out many times, and leave the connection unimpaired. We have those soldered to the hanger-board binding post at the station. This leaves the lineman nothing but an ordinary line joint to make, which he can do outside easily and well. I cannot say that that is done on all our circuits because of the hurried way in which the plant was put in operation, and because we put in 1,200 lights at the very outset, and so there is more or less of the old construction which has now been overhauled. But generally we have no connections in our station except solid soldered connections, except where a lamp is connected to the hanger-board. We have a hook hanger, and also have a binding post on this hook on the lamp. We hook the lamp into the hanger-board hook and solder a short piece of cable, which we put in a binding post and set it with a screw. Thus we get a double connection where we cannot have a solid connection. There is no hanger-board that I have seen and no method of hanging lamps by hook or connecting than by a single connection to the hanger-board that will not develop trouble in ordinary practice, but by using the double connection you get very good protection. I have mentioned in the paper that it is our practice to charge the customer for arc light installations. I am aware that this practice does not generally obtain throughout the country. One of my employés, who came to me from an older company, once told me that I was wrong in attempting this; that the thing could not be carried out; that it would make trouble and give us bother in endeavouring to collect from or compel customers to pay for arc light installations. I maintain that there is no more reason why we should do wiring free than there would be for a gasman to charge nothing for piping a house. There is no more reason why a gasman should pipe a customer's house than there is for our wiring a house for incandescent lamps. Of course, in the early day, when arc lights were still an experiment, we were anxious to get the thing in a man's house so that he would try it, hoping that if he liked it he would keep it, and so we did not charge for wiring. And later on the same thing prevailed, and to get a customer started we were willing to do the wiring for the sake of getting him converted from the present method of lighting by gas to the new method by electricity. And so that practice has been followed up because the precedent had been established. But there is no sense in it—no matter how much you think you cannot get away from it. It is like anything else. If you charge for the wiring there is likely to be an awful kick at first, but it will soon wear away, and men will finally come to recognise it as a correct business principle—that you have got to make from some other source the money which you spend in putting in lamps, and that if you are making a fair rate of profit on your lamps, if you have still to add this extra cost of wiring to it, you increase the cost, and if you place this increased cost of the lamp on the man who keeps the light for but a few months, then you are imposing on the man who keeps his light for a long time. We have effected a saving or decreased our expenses more than 600dols. a month by refusing to put in the lamps free. We make a charge of 35 cents per hour for all labour except that of the foreman, and we charge 40 cents per hour for his time. We also charge for the horse and waggon at the same rate, and we charge from the time the men leave the station until they return. That charge will usually cover the time of connecting it in circuit, and the cost of the minor things which we never take out—in the way of screws, insulators, and other such little things—and perhaps also the cost of removing the wires. We have another shrinkage there in the scrap wire which comes in, and which may or may not be covered. But in a measure this charge covers largely the expense. We make a point with our customer that we want to own those appliances, that we bear the cost of them, but that we want to charge him for the labour, and we charge for the labour in that way. We do not pay those prices, as you understand, to our linemen. We own our own teams. The horse and waggon is worth 4dols. a day to us, charging at that rate, and do not cost us anything. I know that there is a good deal of objection made to this plan, and, in fact, the president of our company said that I was taking a wrong stand, but it did not make any difference to us, and after the first few months all objections were gone. Many of our customers require only short-service lamps, as from October to the 1st of January, or perhaps through the winter, taking them out in the spring,, and we have customers who take lamps for six months in the year only, their business being of such a nature that they do not require them longer. These people want the lamps every year, but not for all the year, but still they do not want their wires taken out; and so to save increased expense to them, and to avoid the taking out and putting in of wires, we require them to sign a contract, when the period of service expires, for the succeeding season. Then we leave the wires in, and agree to connect them without cost. But for own protection we disconnect them entirely from the circuit. We always cut the wires out of the building, close the circuit at the pole, and take down the loop leading to it. I am satisfied that it is well worth the cost to do this, for then we are in no danger of burning them up, and by cutting them off, closing up, and making a solid circuit we do not have to look for trouble from cut-out boxes or other bad contacts, nor do we have trouble. The place where men never think to look for trouble is in these dead wires. They forget them. While this costs a little money, I think it saves a little in the end

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* Paper read before the Convention of the National Electric Light Association.

Civil Engineers.—The council of the Institution of Civil Engineers invites original communications on subjects, a list of which is issued. For approved papers the council award premiums from the Telford fund, Manby donation, Miller fund, Howard bequest, Crampton bequest, and Trevithick memorial fund. Amongst those proposed the following more especially relate to electrical science; appliances for tunnelling; ventilation in tunnels; distribution of water power in mines; best arrangement of engine for central stations; application of electricity to the treatment of sewage; mechanical propulsion for lifeboats and small undecked boats; systems of underground haulage in mines; electro-deposition of copper; electric traction for roads and railways; electric motors for (*a*) inland navigation (*b*) ocean vessels; best form of electric light mains having regard to durability, economy of material, and facility of house connection; application of electricity to smelting and metallurgical operation; electric measuring instruments, as ammeters, voltmeters, power and supply meters. The papers must avoid the use of the first person, be legibly transcribed on foolscap, leaving a margin, be prefaced with an abstract, and the illustrations, when necessary, should be on tracing paper and not over 6¼in. in height. Diagrams to be large enough to be clearly visible 60ft. away. Papers already read or published are not accepted. In adjudication of the awards no distinction, except in the case of Howard and Miller bequests, will be made between papers received from members or strangers, whether native or foreign. The following are among the premiums awarded during the last session: A Telford medal and premium to Rookes Evelyn Bell Crompton, M.I.C.E., for his paper on "The Cost of the Generation and Distribution of Electrical Energy," and a Telford premium to William Langdon for his paper on "Railway Train Lighting."

NEWS FROM THE PENINSULA.

ELECTRICAL ENGINEERING, LIGHTING, PRICES, AND CO-OPERATION IN THE SPANISH CAPITAL.

[We give the following from a correspondent in Madrid, almost as it was received, for the purpose of allowing English readers an opportunity of knowing how electric lighting is understood in Madrid. We doubt very much if any engineer of repute in this country would be bold enough to suggest a number of small installations for the lighting of a large town. It is evident, however, that our contemporary *La Revista Minera-Metalúrgica*, has formed this conclusion.—Ed. *E.E.*]

MADRID, *Tuesday.*

Madrid, with nigh half-a-million inhabitants within the city limits, is not making the progress in intelligent electric lighting which it might. Barcelona, the second town of the Spanish part of the Peninsula, is away ahead, and its *ramblas* are, perhaps, the best arc-lighted public walks in Europe. There is no stretch of boulevards even in Paris so well illuminated.

Among the constructors of electrical apparatus in the Hispanian capital of Madrid (but it is not the commercial metropolis, which rank pertains to the industrious capital of Cataluña) are notably J. Gonzalez, calle [street] Infantas 4; and I. Sierra, c. Lobo 8. They are progressive men, or would doubtless like to be thought so; but to an American or British professional they will appear rather ancient. Among the working electrical engineers may be cited the names of L. Page, Plaza de la Independencia 5, A. Martinez, calle Carretas 41; E. Olalde, c. Sordo 11. The two electrical companies are located: Electricidad Berlin, at Carrera San-Jeroñimo 42; and the Electricidad Matritense at reina-Mercedes 24. The mining institute, or Circulo Minero Industrial, is at Relatores 4; and the Cientifico y Literario Ateno (athenæum) at Prado 21. These establishments are provided with fine reading-rooms, receiving numbers of journals from the two hemispheres, and are frequented by the pick of Spanish commercial people.

As is always the case in Spanish officialdom, there is a good deal of jobbery in electric light circles where the public purse is concerned. And not alone in Madrid, but in other cities. There was a scandalous revelation recently in Barcelona over the conduct of one J. Guíu, a scrivener employed in the Ayuntamiento, or local guildhall. He was found out in a number of shady practices—transpired to be, in fact, a vulgar *pillo-bribon*. Yet, to give readers an idea of what the Augean stables are like, it is only necessary to state that he does not lose his position. If threatened with dismissal, Guíu would round on some of the other functionaries, and threaten them, too, with exposure if they did not use their influence to hush the matter up. So the affair has been stifled, from the alcalde (mayor), who knows all about it—M'l Porcar-y-Pio—down to the liveried officials. Press liberty is not of a high standard in Hispania, and it would go hard with the publication in which these lines appear were it printed in España. There must be something wrong somewhere with the Barcelona Municipality.

A most interesting paper has recently appeared in Madrid, taking in hand the entire subject of co-operative electric lighting. It shows how electricity might be made the predominant nightly illumination in the capital at less than half the price of petroleum or paraffin, which latter actually costs $5^{\cdot 30}$ pesetas monthly, whereas an electric light of 10 candles, working five hours daily, would cost, with interest and amortisation on the capital, $3^{\cdot 10}$ pesetas monthly, to be reduced subsequently to 2¼ pesetas. The peseta is equal to the franc in Gaul, or to 20 cents American. The céntimo is the hundredth part of a peseta, or the fifth part of a cent U.S., or halfpenny English. The céntimos are the small figures.

Some extracts will be made at length from this learned essay on co-operative cheap electric lighting, worthy of attention in other than Spanish cities—in Albion and in America—and to preserve the literal purity of the original, the faithful translation will even preserve some of the peculiarities of Iberian expression.

However difficult it may be to fight with the indolence and indifference of a neighbourhood as that of this capital, a fact so extraordinary and so exceptional as that they might have electric light in Madrid cheaper than petroleum cannot fail to become known to somebody who will—be they private concern or corporation—take the trouble to demonstrate it. This surely cannot be expected from the strange companies which come precisely to exploit the industrial ignorance of España, and the failing of the spirit of enterprise, as one will find in Central Africa. While the actual companies insist on the base price of 1 peseta 20 céntimos, the light of 10 candles and five hours daily, it will cost for the month 6½ pesetas, and although this is already lower than gas at 40 céntimos burnt in the ordinary burners, it is still dearer than the 5 pesetas 10 céntimos which petroleum costs for the same time and intensity.

This done with, it is convenient to examine in the first place if the enterprises of Madrid might and must sell electricity at London price. There is not the slightest doubt that this can be done, and to urge it we will demonstrate practically. The production of the electric current costs to day in Madrid somewhat more than in London by reason of the higher price of coal; but on the other side, this should not be thus, because it will cost less when the railways lower the present high and exorbitant rates. If in London the light costs, for 10 candles running five hours per day, 3 pesetas 67 céntimos per month, in Madrid, even establishing the price of 80 céntimos for compensating for the greater cost in coal, it would cost 4 pesetas 22 céntimos.

We have wished to put this clearly and positively that the electric light, within the circumstances of the present day, can and ought to be the exclusive light of Madrid, because it can be absolutely the cheapest, even supposing that the electrical companies here vend it at the general prices in Europe of 70 to 80 céntimos the 1,000 watts, and not the exaggerated rate established.

The electric light does not necessitate monopoly to be cheap, and may be handed over to the most extensive competition. If the municipal corporation approaches the companies to ask electric current for the lighting of the public ways, it arrives at one of these two extremes: either the actual budget for public lighting will increase in an unmeasured degree, or if the suppliers sell electricity to the municipality at the price which they ought—50 céntimos the 1,000 watts (price equal to that of Newcastle)—it will be at the cost of wishing to acquire rights for perpetuating the high prices of electricity which they sell for private lighting.

If the modifications which we propose are carried out, the business of supplying current will be eminently national, and the foreign enterprises will not be able to take a lead in it.

Two great errors are bearing on España and in all parts upon the supply of the currents for electric lighting: the one is to create installations of the grandest sort possible for supplying currents at long distances; the other is to pretend to a uniformity or approximation in the prices of sale, depreciating the great difference of the cost.

The radical reform which we propose for the applications of electricity in Madrid is that there be made a number of installations, with radius of maximum service of 250 metres.

We have already said that the high charges on the cost of the electric light must be imputed, not to the production, but entirely to the distribution and to the exigencies of this on being installed. It can be established in an undoubtable mode that the prime cost of the electrical unit produced in the vicinity of the machines in installations of 25 h.p. will not pass in Madrid, with all reckonings, 23 céntimos; but if the current of equal tension is supplied at 2,000 metres from the place of production, surely it will have doubled; but if it is solely to be supplied at 40 metres it will scarcely have augmented, and even at 250 metres the augment would be completely insignificant, therefore, the installations which limit their radius of supply to this distance as a rule can count with all certainty that the cost of the electricity distributed will be for them at most 35 céntimos for the unit of 1,000 watts, including the renovation of lamps.

The installation of motors, dynamos, and wires for distribution will cost 100 pesetas per lamp. Thus, therefore, counting 15 per cent. annually upon this amount for interest and amortisation, we have the normal light of 10 candles for service of five hours diurnally, which could be sold at the following per month :

	Pesetas.
Per prime cost of service, 35 w., 5 × 35 × 30	$1^{\cdot 85}$
Per interest and amortisation of the capital	$1^{\cdot 25}$
Per month	$3^{\cdot 10}$

Being therefore known that this same light with petroleum will cost 5 pesetas 10 céntimos per month, it remains demonstrated, as we thought at the beginning, that the normal electric light can be made the cheapest of all lights possible for Madrid.

There are, however, causes which tend to the lowering in price and increase in price. The causes of reduction of the typical cost are :

1. When an installation of 400 lights can be employing accumulators, supply 800.

2. When, already being supplied, the 400 lights or the 800, still they can supply current for motors during the day. In both cases the cost of the unit of current is equal, but the amount assigned for interest and amortisation can go from the simple to the triple. Thus it is that the monthly price of the five hour light may be $2^{\cdot 26}$ or $2^{\cdot 70}$ pesetas, according to the case.

The cause of enhancement of this cost is that an installation of 400 lights of five hours does not meet with the necessary demand. In this case the prime cost of the current will rise somewhat, but the major difference is in the interest and amortisation, which continues the same. There is not a block in Madrid which has not at least 200 lights to serve, and from the moment that petroleum is dearer than electricity, it may be felt that there will not be a householder who will not use this latter.

It may be said that the minimum and maximum limits at which the electric light may be sold in Madrid, the capital obtaining the current interest and amortisation, are from $2^{\cdot 26}$ pesetas per month to $3^{\cdot 60}$. In this is not included administration nor industrial gain. Thus it can be said, and for the same reasons, that if the light of five hours can be contracted for at $3^{\cdot 10}$ pesetas per month, there is no reason that the 10-hour light should be made to pay $6^{\cdot 20}$, because in the second five hours the interest and amortisation continues being $1^{\cdot 25}$, so that the 10-hour light is solely worth in justice $4^{\cdot 95}$.

The small installations are not new in Madrid. Those of the theatres of Lara and Novedades (which give light to particular consumers in their environs), the installations of the príncipe Alfonso, the Zarzuela, the Princessa, the Equitative building, etc., although not being all so perfect as they might be, have already taught and confirmed this important truth, that the cost of electricity per 1,000 watts supplied in the neighbourhoods of the installation is very diverse from that supplied at a great distance, and therefore the big stations can never offer current at the price at which it can be offered by the small ones.

The small installations which can be put into inhabited edifices must be limited to the force of 25 horses, which can supply normally, by direct continuous current, 400 lamps of 10 candles, and therefore it would be probable that generally each installation would supply the necessary current in the square in which it is installed, and may in some cases of necessity supply the next square also.

The special requirements for Madrid, in order that the applications of electricity produce all the conveniences of which it is susceptible, should have the following bases: 1. Neither the motors nor dynamos shall produce smoke nor noise. 2. The installations will be subject to the inspection of the Municipality. 3. The concessions shall be for 10 years, revocable at the termination without indemnisation; and if before, with indemnisation for prejudice or damages. 4. Maximum size of motor in inhabited edifice, 25 horses. 5. The concessioners shall be obliged to install and to work, until one o'clock a.m., in the public thoroughfares two lights of 400 candles for each machine of 25 horses, and one light of 25 candles at the external door of each house to which current is supplied, which shall be lighted from sunset to sunrise. 6. The installations to be accommodated to a regulation, which will be considered provisional, and which may suffer modifications, so as to reach to and affect installations already made. 7. The installations shall pay for rights of inspection and statistics two pesetas per horse per year.

We will now consider the multiplicated petty installations. For entering in these details, we will return to take the type of the light which we consider the most general case—of 10 candles used five hours each night—and we will aggregate that there is being treated one of the infinite *manzanas*, or squares, which there are in Madrid, in which can be distributed and supplied 400 lights of 10 candles.

Considering, therefore, the business as such, we will see, before all, that as it is to treat of eliminating petroleum, the cost of the light of this is the parting point ; and as such, whoever makes the installation merely as speculator has to consider that the petroleum light costing $5^{\cdot 10}$ pesetas per month, plus the breaking of the tubes, the leakages of petroleum, and the trouble of providing the lamps, there is decided advantage for the consumer in offering the electric light at five pesetas per month. It is already demonstrated that to the speculator it costs, with interest and amortisation in the typical case, $3^{\cdot 10}$ pesetas, and therefore there would be $1^{\cdot 90}$ pesetas of profit per lamp and month, or say 760 pesetas monthly, or rather 9,120 pesetas per year in each typical station of 400 lamps which sells the electricity at five pesetas, which would be cheaper than petroleum.

Now, then, the capital whose interest and amortisation is already counted in the cost of the light will be 40,000 pesetas, and therefore the utility or profit of the 9,120 pesetas annually is the industrial gain, apart from the interest, whose gain should not suffer other lowerings than the very small one which corresponds to the administration of a business so simple, which is all done in the same square ; and, furthermore, the contribution to the State which corresponds for the installation of a motor of 25 horses and the dynamo, which should not pass 200 pesetas. The installation will render also the charge in favour of the municipality of two lights of 400 candles for six hours, and some eight of 25 for the public ways for 11 hours ; but this charge solely represents the cost, and is not to exceed 500 pesetas in the year. Supposing, then, that each installation pays 800 pesetas per year to a collecting clerk who keeps the accounts, and as this clerk can at the same time discharge the same employ in various installations, as such, the charges against the 9,120 pesetas of profit are 1,500 pesetas. There remains as net gain upon each installation 7,620 pesetas, which to us appears an excellent compensation for work for which they have (their own or loaned) 40,000 pesetas of capital. Even with the price reduced there would be a good profit.

The ultimate point of view from which we wish to examine the reform of the lighting in Madrid is the co-operative one. In its most simple form it can be presented in the following manner :

The inhabitants of a *manzana* (block of buildings) who require 400 lights, being of accord, will co-operatively obtain an installation, and employ their own servants. The capital of the 40,000 pesetas would be obtained by each one contributing in proportion to the lights which he installs at the rate of 100 pesetas each one. As it is a question of substituting gas and petroleum—and this last, which is the cheapest, costs $5^{\cdot 10}$ pesetas per month—the co-operative electric light would be paid for at five pesetas monthly, the surplus payment going to reimburse the capital. This reimbursement would be complete within four years from the working of the light, and then there would be no reason to pay for the light at five pesetas, but solely at $1^{\cdot 85}$ pesetas, except the maintenance, which is the cost without interest or amortisation ; this is practically at $2^{\cdot 25}$ pesetas per month, which constitutes a veritably cheap light in every sense.

This is the most simple form in co-operation for obtaining electric light ; but there is a form more complicated, yet even more convenient, because it gives the same result without money being advanced by the consumers. The householders agreeing to install the co-operative light agree to pay for so many lights per month at five pesetas during five years, whether the house is inhabited or not, and with the aid of this agreement they get their loan with interest of 40,000 pesetas, which would be reimbursed by the gain within the five years with its interest, and once the reimbursement made, they would enter on a period of having the light at cost, or say 2½ pesestas per month.

[The writer acknowledges his indebtedness for the foregoing information on co-operative electric lighting for Madrid to the paper of J. Gómer Hemas, editor of the semi-electrical weekly of Madrid—*La Revista Minera-Metalúrgica.*]

AUSTRALIA.

Under the title of the "Electrical Club of New South Wales," our colonial brothers have banded together in Sydney. The inauguration of the new association took place in Sydney on September 8th, when the various officers were elected. Of course the inauguration included the inevitable dinner. Colonel Cracknell was elected president of the association, and presided at the dinner. We can only give a brief account of the meeting, and must leave the toasts proposed by Captain Rowan, Mr. Whiffin, Prof. Threlfall, Mr. Nelson, Mr. Arnot, Mr. Masters, Mr. Callender, and others unrecorded.

Mr. **Cracknell**, on rising to address the gentlemen present, said that as they had been in close circuit long enough, they would now approach the business of the evening. His first duty was to briefly explain the objects for which it was proposed to form this association of electricians. He was delighted to see such a large number present, especially as they were directly representative men; so that in establishing the Electrical Club of New South Wales they would know that it was a thoroughly representative institution. He would not make an elaborate speech, but content himself by briefly stating that the objects of the club would be—first, to bring the representative members of the profession together socially, to enable them to promote the interests of electrical engineering generally, and to take concerted action in all matters of importance affecting those interests. Without some action of this kind they would continue to be like a ship without its stearing gear, drifting about in all directions without a governing power. The interests they all had at stake were becoming far too important to be any longer neglected, and it was his opinion, and he trusted the opinion of all present, that they should now form themselves into a society, and provide rooms for holding periodical meetings for discussing the progress and constant development of the science which for many years they had watched so carefully, and to which they had added their mite, no matter how small, to build up a structure of which every man amongst them must be proud. They were not all Humphry Davys, Faradays, or Edisons, but they had all helped in their particular spheres, and had done their best, without the assistance of a club, or any other organisation; but how much more useful would they become to the community at large, and themselves in particular, when they formed a society for discussing the important matters which were almost daily being presented to their fellow-workers in other parts of the habitable globe, where kindred societies and clubs—such as the Dynamicables and Electro-Harmonics—existed. While on this subject he might ask, in support of his argument, where would electric lighting have been at the present day had it not been for the leading members of the Dynamicables, with Lord Rayleigh as their president, who literally took the British Parliament by storm, and succeeded in getting a workable Bill, which removed previous disabilities, and gave a fresh impetus and assured commercial success to city and private lighting in Great Britain? Even socially, their proposed little club would be a great boon. They could meet in friendly discussion, talk over the world's news, read their scientific journals, give occasional papers relating to professional subjects, and, he hoped, be able to smoke the calumet of peace. He felt assured by their presence there of their hearty support, and he now formally moved that the Electrical Club of New South Wales be formed, and the executive appointed, consisting of a president, two vice-presidents, secretary, treasurer, and a committee of five members. It was their duty to try and make the club a great success, and on looking around the board he saw there all the elements of success if they would go in heart and soul on behalf of the great interests they had at stake. These large interests should be properly represented, and there were matters of overwhelming importance which required them to lay their heads together so as to watch them for the best interests of the community. He would not say much more then. At a future date he might deliver them an address, but at present they could do nothing but talk about themselves until the club was properly formed.

Mr. O. **Haes** (Brush Electrical Company) said he felt somewhat diffident as one of the newest additions to the electricians of New South Wales in following their worthy chairman. He heartily endorsed what Mr. Cracknell had said about needing an association to look after their interests, and he was sure they would all agree with him that they needed a good president to begin with, and that no better man for that position could be found than Mr. Cracknell. It might seem an impertinence for him to propose him, but, short as had been his stay here, he was convinced he was the very man for the post, and thought it was the least they could do to ask him to honour them by accepting the presidency of the club; for that purpose he would move "That Colonel Cracknell be elected the first president of the Electrical Club of New South Wales."

Mr. J. R. **Williamson** (Williamson Electrical and Engineering Company) said he believed he might take it for granted that Colonel Cracknell had been elected president, and he would congratulate him on that fact. He thought they would all look back to that evening with pleasure, and recognise the fact that the club would prove an important factor in the future of matters electrical in New South Wales. If such an important gathering as that could be got together when it might be said that electrical science in Sydney was yet in its boyhood, they could see what great weight the club would have as they progressed. It was very gratifying to see amongst them gentlemen from Melbourne, who were surprised that they could gather in such force. He now moved: "That Mr. H. H. Kingsbury and Captain F. C. Rowan be elected vice-presidents of the Electrical Club of New South Wales." Either of them was well capable of filling the chair in the absence of their president. Mr. H. H. Kingsbury was an electrician in the colony before most of them came to it, and in Captain Rowan they had a gentleman—if of recent residence here—well known in Melbourne as an electrician for many years past. They also needed a treasurer, for which office he proposed Mr. J. O. Callender, and for secretary Mr. A. C. F. Webb. Besides these they were in want of a committee—not a large one, "as too many cooks spoil the broth" as a rule. He would propose that Messrs. G. Hamilton, A. H. Whiffen, P. B. Elwell, R. Oxlade, and Oswald Haes be the committee. In these gentlemen they had representatives of the five principal electrical companies in Sydney, and he was sure they would be found most capable of arranging the business and pleasures for their occupation on future evenings.

Mr. **Fitzmaurick** seconded the resolution. He said it needed no words from him to advocate the selection made, for every gentleman named was well versed in electrical matters and most suitable for office. There was only one matter which presented itself to them, and that was whether they would be strong enough to maintain this separate institute. Several proposals had been before them, suggesting affiliation either with the Royal Society or the Engineering Association of New South Wales. If he expressed his own desires it would be in favour of affiliation with the Engineering Association, as many of them were already members of that body, and they were in their occupation naturally closely allied to the engineers.

Mr. **Kirkland** thought a ballot should be taken for the committee, and with that object in view he begged to nominate Prof. Threlfall as a member of the committee. He did not think the committee would be truly representative of that meeting without Prof. Threlfall's name added to it.

Messrs. Cracknell, Rowan, Callender, Kirkland, Fitzmaurice, H. H. Kingsbury, and P. B. Walker took part in a discussion as to what should be done in this matter, when Mr. **Kirkland** withdrew his motion for a ballot to be taken, with the understanding that the committee be increased to six members by the addition of Prof. Threlfall's name.

This was carried by acclamation.

Mr. CRACKNELL returned thanks for the honour conferred upon him by being elected their president, pointing out that he had been identified for 36 years with the science which was how developing into such enormous proportions.

Mr. H. H. KINGSBURY made a lengthy speech, in which he claimed to himself the credit of having introduced into New South Wales many of the modern improvements in electric lighting, even before they were in use in England. He asserted that the incandescent light was used in Sydney before it was in London, and credit was given to him by the *Electrical Engineer* for having accomplished this and other matters of a similar character. Mr. Kingsbury's remarks caused a great deal of amusement, especially his description of the "agonising pain" he endured when he went to England and saw what very inferior work was done there, and which he described as "infernal." He maintained that as an investment for capital, electrical enterprises were unequalled. They absolutely had the world at their feet. He thanked them for the honour done him in electing him one of the vice-presidents.

LONDON COUNTY COUNCIL.

At the last meeting of the County Council the Highways Committee reported as follows :

We have considered a notice, dated 28th September, 1891, from the Electric Installation and Maintenance Company of intention to lay mains from Springfield Wells-road, Sydenham, along Springfield, to and along Wells-road to its junction with, and along, Sydenham-hill to the north end of the Crystal Palace. This, the first notice under the Crystal Palace and District Electric Lighting Order, 1890, is for a line of high-tension mains from the Springfield generating station to the Crystal Palace. It is intended to use lead-covered cable, laid in stoneware pipes surrounded with concrete when laid in the carriageway, but uncovered when under the footways, and the street boxes are shown as with single covers of iron. We are of opinion that the proposed works may be approved subject to the conditions stated below, and we recommend :

> That the sanction of the Council be given to the works referred to in the notice dated 28th September, 1891, of the Electric Installation and Maintenance Company, upon condition that the company do give two days' notice to the Council's chief engineer before commencing the works ; that the pipes be laid at such a depth that the top of them shall be at least 2ft. below the surface of the ground ; that the pipes be laid under the footways wherever it is found practicable to do so ; that the pipes where laid under the footways at a less distance than 6in. from the kerb or under the carriageway shall be surrounded with concrete ; that provision shall be made for preventing accumulation of gas in the street boxes ; that for the top course of brickwork in the boxes as shown on the plan, 3in. York stone shall be substituted ; that as an additional precaution against accident through defective insulation of the mains, each of the street boxes shall be provided with an inner as well as an outer cover, the two insulated from each other as far as practicable, and that the outer cover, which shall consist of an iron frame filled in with material to suit the paving, shall be efficiently connected to earth.

A notice, dated 2nd October, 1891, has been received from the St. James and Pall Mall Electric Light Company, of intention to lay mains across Pall-mall at John-street and Waterloo-place. The works are of the usual character, and there seems to be no objection to them. We recommend :

> That the sanction of the Council be given to the works referred to in the notice dated 2nd October, 1891, of the St. James and Pall Mall Electric Light Company, upon condition that the company do give two days' notice to the Council's chief engineer before commencing the works.

The Notting Hill Electric Lighting Company has given a notice, dated October 7th, 1891, of intention to lay mains along a part of the north side of High-street, Notting Hill ; line to No. 39, Linden-gardens, and lines to No. 24, Dawson-place, No. 6, Pembridge-villas, and to the Convent of Zion, Chepstow-villas West. The proposed works are unobjectionable, and we recommend :

> That the sanction of the Council be given to the works referred to in the notice of the Notting Hill Electric Lighting Company, dated October 7th, 1891, upon condition that the company do give two days' notice to the Council's chief engineer before commencing the work ; that the cover-stones of the culverts under 20in. wide shall be not less than 2in. thick, and of the wider culverts not less than 2½in. ; and that where the culvert crosses the carriageway, there shall be at least 9in. thickness of Portland cement concrete above the cover-stones of the culvert, in addition to the road material.

We have also considered a notice dated 14th October, 1891, from the House-to-House Electric Supply Company, of intention to lay mains in Queen's-gate (part of) and Mason-place (part of). These works are of the usual character, and we recommend :

> That the sanction of the Council be given to the works referred to in the notice, dated 14th October, 1891, of the House-to-House Electric Light Supply Company, upon condition that the company do give two days' notice to the Council's chief engineer before commencing the work ; that no pipes of a larger diameter than 6in. shall be used ; that the street boxes to be used shall be of the pattern approved by the Council ; and that as an additional precaution against accident through defective insulation of the mains, each of the street boxes shall be provided with an inner as well as an outer cover, each insulated from each other as far as practicable, and that the outer cover shall be efficiently connected with earth.

We have also to report the receipt of the following notices, given in accordance with the resolution of the Council to accept four days' (instead of one month's) notice in respect of the laying of service lines from mains already laid :

From the St. James and Pall Mall Electric Lighting Company—2nd October, to 90 and 192, Regent-street, 10, St. James's-square, 3, St. James's-street, and 13, Burlington-street ; 5th October, to 99 and 143, Regent-street, and 200, Piccadilly ; 12th October, to 98, Regent-street, 2, Vigo-street, and 28, Old Burlington-street ; 15th October, to 220, Regent-street.

From the Electricity Supply Corporation—6th October, to Craven House, Northumberland-avenue ; 15th October, to Messrs. Haxell's premises, Exeter-street.

From the London Electric Supply Corporation—8th October, to the Doré Gallery, New Bond-street ; 8th October, to 21, Haymarket.

From the Westminster Electric Supply Corporation—5th October, to 40, Wilton road.

LEGAL INTELLIGENCE.

IN RE ELECTRIC ARMS AND AMMUNITION SYNDICATE, LIMITED.

Winding-up Petition.

A petition to wind up this company on the ground that the substratum of the company had entirely failed came before Mr. Justice Jeune in the Chancery Division of the High Court on Wednesday. The company was registered in October, 1889. The nominal capital of the company was £40,000, divided into 400 shares of £100 each, of which 290 have been issued. The amount of the capital paid up, or credited as paid up, is £25,450. The objects for which the company was established are as follows : (a) To enter into and carry into effect, with such modifications (if any) as might be agreed upon, the agreement with the American Electric Arms and Ammunition Company mentioned in clause 2 of the company's articles of association, and to purchase or otherwise acquire any other inventions or patents. (*b*) To use, exercise, develop, grant licenses in respect of or otherwise turn to account any inventions or patents belonging to the company and with a view to the working and developing of the same to carry on any business which the company may think calculated, directly or indirectly, to benefit the company. (*c*) To purchase, take on lease or in exchange, hire or otherwise acquire, any real or personal property, rights, or privileges which the company may think suitable or convenient for any purposes of its business, and to erect and construct buildings and works of all kinds and other objects set forth in the memorandum of association. The agreement referred to in (*a*) provided for the sale to the company by the American Electric Arms and Ammunition Company of its patents for Great Britain, Austria-Hungary, Belgium, France, Germany, Italy, and Spain, granted in respect of the vendors' system, whereby electric firing is substituted for percussion locks and fulminating primers. It was stated that the patent for the working of which the company was formed had been found to be defective, and the directors were spending money in experiments in order to try to remove the defects or otherwise to make the principle workable. There had been a meeting of the company, at which 10 shareholders attended. Four of these, holding 25 shares, had voted for the winding up of the company ; six against, holding 16 shares. The chairman then declared that the majority were in favour of the company continuing, on the ground that the votes of those in favour of winding-up the company were invalid, as the calls on those shares had not been paid.

Mr. Justice Jeune dismissed the petition with costs on the ground that the company were not exceeding their powers.

Mr. Marton, Q.C., and Mr. Eustace Smith appeared for the petitioners ; Mr. G. F. Hart, on behalf of a shareholder, supported the petition ; Mr. Millar, Q.C., and Mr. Maclaren appeared for the company ; Mr. Rolt and Mr. Ere, for shareholders, opposed the petition.—*The Times.*

COMPANIES' MEETINGS.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.

The thirty-sixth ordinary general meeting of this Company was held at Winchester House on Wednesday, the chairman, Sir James Anderson, presiding.

In moving the adoption of the report, the **Chairman** said that he did not know whether they would take the remarks he was going to make as encouraging or discouraging, but he had felt it right six months ago to call their attention to active competition which was arising, and he now felt that he must not keep back anything which they ought to know. He would therefore read the remarks he had prepared. He need only call their attention to a few items in the report and balance-sheet. They had increased their agencies by establishing, especially in Buenos Ayres, a most important agency, which accounted for the increase of £500 in the working expenses of stations as compared with the corresponding period of 1890. They would have to add to this amount in the future for other agencies. They had had to pay £187 for laying on water to their Madeira station. The gross revenue for the half-year showed an increase; it amounted to £158,905. This was exceptional, and was largely due to the disturbances in South America. He would call attention to the fact that the current half-year would have to bear the cost of repairing the cable near Pernambuco, amounting to £10,000, and the cost of duplexing the Company's cables, about £6,000. This would explain the wisdom of carrying forward so large a sum as they had done. As to the £11,200 receipts from messages hitherto in dispute, they could not look forward to the recurrence of such an item in their finances. Neither could they hope, or ought they to hope, for a series of disastrous revolutions such as had increased their receipts during the last six months. They must look forward to a reduction in revenue. Nor was this all. At the last meeting he pointed out on the map the various opposing lines that were being promoted. Since that, one line, the French Antilles cable, extending from Hayti to the vicinity of Para, a short distance from the terminal station of the lines of the Brazilian Company's partners (the Western and Brazilian) had been completed and opened for traffic. At present that line had not done them much harm, but no doubt its promoters would learn how to take some of the traffic. He did not know if they intended to lower the tariff, but it was not their (the Brazilian's) policy to initiate a war of tariffs. The Central American Telegraph Company had come into active rivalry and competition for traffic with them. As to the amount of injury these rivals could do them in the future, a great deal depended upon the question of their adopting an unremunerative tariff. There was another rival in the cable from Senegal to Pernambuco, which they were assured would be laid in about six months. The amount of injury this line would do them would depend also upon the tariff adopted. Whatever tariff was adopted, the Brazilian would adopt, or a lower one; and beyond all controversy each of their rivals would regret a war of tariffs more than they (the Brazilian) would. The Company had no right to complain of this competition, though for a good many years they had struggled on without an increase in their revenue, and had borne the heat and burden of the day. They must let sentiment alone. They had seen the possibility of these lines coming into existence for years back. There was no way to stave them off. They had left others to try this experiment, and had kept their money. They had had their dividends averaging a trifle over 6 per cent. for 17 years. The Board had adopted the policy of increasing the reserve, and had laid another cable out of it—thus increasing their carrying capacity without adding to the capital, so they were able to convey the large traffic which a reduced tariff might develop. This Company had duplicate cables throughout, and their partners, the Western and Brazilian, had duplicated their system over the most important sections, and both companies were establishing duplex working. They had thus made provision which, with their experience, should secure them a large share of traffic. He might here say that they were not without resources to carry their energies into the pastures of their rivals. The Directors were not neglecting the question of harmonious working with their partners, the Western and Brazilian, and extending their lines when they could do so. He knew he was speaking rather vaguely, but they must trust the Board. Duplexing would cost them money. They would need a larger staff, and he personally would be willing to sacrifice something to carry out extensions. He congratulated them, therefore, that besides paying a good dividend, they were carrying a good sum to reserve. It was not too much, however, when they considered that they had the maintenance and life of two cables to provide for. They were as ready for the fray, if fray it must be, as any of their rivals, who had so far only single cables. He was not going to boast. They had seen the probability of this competition a long way off, and he thought it only fair to warn shareholders that they must not expect the continuance of an 8 per cent. dividend. They must be prepared for a falling off in their revenue, and they must keep all the money they could in their reserve. It was altogether to their best interest that this should be done. At the same time they did not stand alone. The Globe, the Western and Brazilian, the Eastern, and other companies were interested in their prosperity. This rivalry might be a blessing in disguise. He did not take a desponding view of the future. Since 1876 they had from time to time made reductions in their tariff, varying according to locality from ½ to 57 per cent. of the original one, and they would probably have reduced the tariff further before now, but for the rival cables springing up. Now, however, they thought they were justified in pausing and waiting for their rivals to take the first step. For them (the Company) to reduce the tariff now would be a deliberate throwing away of money, and would not stop their rivals from going on with their schemes. This and other points were subjects of daily consideration with the Directors, and he ought not to add another word as to their policy or plans at that moment.

The motion was seconded by **Mr. F. Joule** and carried unanimously.

The Hon. W. St. John F. Brodrick, M.P., and Lord Sackville A. Cecil having been re-elected directors, the auditors, Messrs. Henry Dever and John Gane, were also re-elected.

A hearty vote of thanks was accorded to the Chairman and Board.

EASTERN EXTENSION TELEGRAPH COMPANY.

The thirty-sixth ordinary general meeting of this Company was held at Winchester House on Wednesday, Sir John Pender in the chair.

In moving the adoption of the report, the **Chairman** said the gross receipts for the half-year under review (ending 30th June last) showed a substantial increase of £10,022, which would have been greater, but that the accounts included two months' receipts at the reduced rates to Australia. The working expenses showed a decrease of £5,194, which was accounted for by the ships' expenses being lighter than in 1890. The net revenue had amounted to £155,165, which showed an increase of £18,490 over the same period of 1890. After allowing for payment of dividends (*vide* report in last week's *Electrical Engineer*) a balance had been carried forward of £92,665. The Tonquin-Hong Kong cable was in good working order, a part having been renewed during the half-year. Several small interruptions had occurred, but the traffic in their cables had been practically unaffected owing to the duplication of their lines. The Madras-Penang cable was broken, but the duplicate line was carrying the whole traffic without delay. Fine weather was now reported in the Bay of Bengal, and as the steamer "Recorder" would be in the vicinity in a few days it was anticipated that communication would shortly be restored. The Company's station at Elephant Point, Rangoon, had been closed owing to encroachments by the sea, and a considerable portion of the cable between that point and Penang had been picked up and used elsewhere. An arrangement had been entered into with the Dutch Government for extending the cable from Penang to Sumatra—the length of line would be about 166 knots. This cable would open up an alternative route to Java and other portions of the Netherlands Indies. He had to announce the death of one of the Board's colleagues, Sir Thomas Fairbairn, who was a director in the early days of the Company. They did not propose to fill up the vacant seat. He was pleased to be able to tell them from the short experience they had had of working with reduced tariffs to Australia—4s. instead of 9s. 4d. per word—that he believed the reduction would be a marked success, that the Company would not lose in any way by it, and that the general telegraphing public would benefit very largely indeed. But in saying this he must distinguish between the Australian colonies, which were English-speaking and knew the value of the telegraph and used it for commercial purposes, and India, where the English element was comparatively small. They had never been able to recoup themselves the amount that they lost by the reduction in rates to India and China. He would express his thanks to the agents-general for the colonies who took part in carrying through the negotiations for the above-mentioned reduction. Sir Dillon Bell, agent-general for New Zealand, took an active part in the matter, and was much disappointed at the result—his colony, New Zealand, not sharing in the arrangement. He was going back to New Zealand, and he (the chairman) believed, if he took part in politics there, he would endeavour to bring the colony into the scheme. In Sir Graham Berry, who also took an active part in the reduction of the rates, and who was returning to Victoria, they would have an intelligent supporter of anything that would bring the colony into closer relations with the mother country. When they (the Company) were progressing well, paying steady and good dividends, and adding to their reserve fund, he thought they ought not to forget those who had been more or less instrumental in bringing about this great result—he referred to their staff. They were anxious that a fund should be promoted for the purpose of giving pensions to those who had been long in the service. This service required intelligence, honesty, and a good deal of self-reliance. There was nothing pleased him more than to find that when their stations abroad were visited by distinguished men from this country, the report always was they were a credit to the country and the Company. Therefore, knowing the value of their staff; knowing the important position they held; knowing that they had to live like gentlemen—the Board wanted them, when the time came that they must retire, to have something to look forward to. He thought the Company in its day of prosperity might fairly contribute to the fund. It was proposed that they should place 5 per cent. on the amount of the salaries at the end of the year in a fund which would go on accumulating. At a certain period of life, when members of the staff retired through ill-health or other cause, the details of their pension would be settled by a competent actuary. Some years ago shareholders contributed to an insurance fund for employés. The Board were going to change this into a pension fund, which would require about £2,000 per annum. Every member of the staff would have to contribute his share—*i.e.*, 2½ per cent. to the Company's 5. In a few years they would have such a fund as would enable them to make it certain that cable traction does not gain the day in the metropolis of the North, for a finer centre for a system of electric cars does not exist.

Heckmondwike. — The minutes of the Electric Lighting Committee came before the Heckmondwike Board of Health on Monday. The committee authorised the employment of professional assistance, and had decided to ask the Lancashire and Yorkshire Railway, and local public bodies, and large private owners whether they would be willing to take the light if provided. The clerk reported that the railway company had replied asking for a copy of the provisional order, so that they could ascertain the rates to be charged. He had received no reply as yet from the Heckmondwike Co-operative Society. Mr. Redfearn, the secretary of the society, who was present, said his committee had decided, with less than two minutes' discussion, to take the light for the whole of their stores if the Board introduced it into the town.

Fire Alarms.—Mr. Robert Lyon, chairman of the Fire Brigade Committee of the London County Council, invites the co-operation of Londoners to prevent the malicious misuse of the fire alarm posts. No fewer than 518 false alarms have been sent last year, sometimes several in the course of one week, each meaning a needless turn out of the engines. It is pointed out that several offenders caught by the police have been sentenced to imprisonment with hard labour. There is a confliction of interests on these public fire alarms: they must be patent to everybody so that no delay need occur, and yet not so obtrusively easy to set off that wanton alarm should be given. If the nuisance continues to grow, as Mr. Lyon states it has done for some time back, it will be probably necessary to give attention to strong means of preventing false alarms.

Worcester.—At the meeting of the Worcester Watch Committee last Friday, Mr. Swete, electrical engineer, reported that, in accordance with the instructions of the committee, he had canvassed the citizens of Worcester for the purpose of ascertaining the amount of electrical energy in the form of light and power that would be required by them in the event of electrical works being established. His canvass had proved that a satisfactory demand for electric light and power existed, in that out of only 388 circulars distributed he received 189 replies taking up arc and incandescent lamps or motors equivalent to 13,660 incandescent lamps of 10 c.p. He had but little doubt that if the enquiry were extended an equivalent to 16,000 lamps would be wanted. Appended were the names of those who would take the light or power. The report was referred to the sub-committee to recommend what should be the next step in the matter.

St. Helens.—A special meeting of the St. Helens Parks and Markets Committee was held on Wednesday to consider the electric lighting of the Town Hall. The surveyor said the sub-committee recommended the adoption of the two-wire system. The other system suggested was the concentric wire; but the authorities would not allow concentric wires for public lighting purposes. They also recommended a vertical boiler for the present to drive the dynamos, that could be removed when the town generally had adopted electricity, as the dynamos then would be in some other place than the Town Hall. The tenders of J. D. F. Andrews and Co., Westminster, for the wire fittings, and of Bumstead and Chandler, Hednesford, for the engines and dynamos, were accepted, the cost to be £1,283; and the town clerk was instructed to make application to the Local Government Board for sanction to the borrowing of £1,500 for the purpose.

Electric Chronograph.—Experiments have been made at Sandy Hook by Captain Heath this summer on the speed of projectiles by means of the Boulanger electric chronograph. In this instrument the shot passes through wire screens in front of two electric circuits. The breakage of one circuit releases an electromagnet, and the armature, a rod of polished soft iron, drops, and almost instantaneously the second electromagnet releases a knife-edge and cuts a mark in the falling iron bar. Calculations show the speed of the projectile between the two screens. This electric chronograph, originally a French invention, has been considerably modified in detail and improved in this country by Captain Holden, and the very beautiful instruments resulting from the combined efforts are made and sent to all parts of the world by Mr. Pitkin, of Red Lion-street, Clerkenwell. The action of the instrument is extremely delicate and accurate, and the principle very interesting.

Chicago Exhibition.—The *Journal* of the Society of Arts for October 23 is taken up with the report of Mr. James Dredge and Sir Henry Trueman Wood upon their visit to Chicago in September. The disposition of exhibits at first proposed was that all electrical exhibits should be in one building, all the mining exhibits in another, and so with other sub-divisions. Arrangements will, however, be made as far as possible to put the main bulk of the exhibits of Great Britain in the industrial building, and other spaces are reserved for use if required. In the electrical section 20,000 square feet are reserved. The storage of empty cases will be at the rate of 1d. per cubic foot. An electric circuit railway will convey visitors to the principal buildings, and on the water electric omnibus boats will perform a rapid service. Prospectuses and forms of application can now be obtained at the Society of Arts Offices, John-street, Adelphi. A powerful committee has been formed.

Stoke.—At a special meeting of the Stoke-on-Trent Town Council, on Monday, the Gas Committee reported, with reference to the proposed extension of lighting, that they had considered the question of electric lighting. As they found that while the cost of producing gas was 1s. 10d. per 1,000 cubic feet, and the cost of producing the same light by electricity would be equal to 3s. 9d., with a capital outlay of £30,000 for new works and plant, they had decided to leave electric lighting until it had been further developed, and they recommended the extension of the gas works. Mr. Green moved as an amendment that as the present works were sufficient for some time yet, they should let the matter rest for two or three years, and wait the result of electric lighting in the towns that were now adopting it. This amendment was negatived, and the resolution was carried by 11 votes to 6, but the town clerk explained that such a resolution required a clear majority of the Council, so that the matter yet remains unsettled.

Blandyte Insulation.—When guttapercha and indiarubber are giving out, it is only to be expected that inventors should give their attention to artificial products. Among those who have turned their attention in this direction, Dr. Blandy, of 58, Brook-street, Grosvenor-square, appears to have been working with considerable success, and to have perfected a compound by the combination and treatment of materials such as waste leather, to be available as a substitute for indiarubber. The cost of "Blandyte," as the composition is termed, is given at 3d. to 6d. per lb., whereas indiarubber is two or three shillings. The material has been tested for cable insulation, and has been favourably reported upon. We are not aware whether the material has been practically used, but the tests mentioned consisted, amongst others, in immersing a covered wire in sulphuric acid and water for 72 hours, no deflection being given with a delicate galvanometer and 10 volts. A company is shortly to be formed to work the patents, not only for insulation purposes, but for hose, belting, shoes, and waterproof garments.

"Lightning."—Electricity in its many forms having penetrated into the very houses of the people, the time is judged ripe for a new popular electrical paper which, under the title *Lightning*, is issued this week, price 2d. The first number of this "popular and business review of electricity" has reached us, dating from the congenial quarters of Faraday House, Charing Cross, under the editorship of Mr. Frank B. Lea. It is a well got up paper of 24 pages, with yellow cover. The contents are varied and interesting. Several serial articles on elementary subjects are started—among them "How the Electric Light is Produced," by W. M. Madden, M.A., "Electric Lighting, from the Consumers' Standpoint," by F. W. B. Gordon. A glossary of technical terms is begun, and the inevitable prize, in a popular form, comes in the offer of half-a-guinea for notice of omissions. The "Ladies' Column" has pretty sketches of interior lighting, and electrical tales and chatty notes make an interesting and readable paper for those desiring information in a less technical form than text-books and technical journals. In fact, to use one of its own jokes, they cannot but be struck by *Lightning*.

Grays.—At a meeting of the Grays Local Board on 22nd inst., Mr. A. W. Boatman said he had been in communication with Messrs. Crompton for the purpose of ascertaining whether the machinery at the sewage pumping station could be so constructed that it could be also used in electric lighting. Messrs. Crompton replied that they would not advise such a utilisation of the pumping engines, as such an arrangement would be very expensive and give trouble in the working. Such a system is used in America, but did not readily lend itself to private lighting. They put the cost approximately for 140 lamps of 32 c.p. each, at £3,600. This would be for two engines and four dynamos and engine-room apparatus, with underground excavations for the wires. The extra cost of a few arc lamps would be about £20 each, fixed in the place. The price given did not include boilers, and the difference between having overhead and underground wires would only be about £250 or £300. Under the circumstances, Messrs. Crompton recommended underground mains, as although they would be more costly, there would be greater security and less unsightliness. The consideration of the matter was further adjourned.

Lightning Conductors.—Dr. Hess, who has been collecting statistics and has examined the tips of many lightning-rods, finds that fusion of the points never occurs. A fine smooth point receives the lightning in a concentrated form, while angle or ribbed, as well as blunt points, divide it into threads. Dr. Hess considers that platinum needles and tips are entirely unnecessary, for they have no advantage over copper points; but as there are lightning strokes which are capable of making wire 0·29in. thick incandescent, unbranched copper conductors should never be of less diameter than this, though in a good lightning-rod the main point is to secure perfect communication between it and the earth. Mr. J. W. Gray, commenting on the statements by Dr. Hess, says that he has known copper 0·29in. thick eaten away by corrosion, whilst a light platinum sheath covering the same remained practically untouched. He adds: "If any of the theorists choose to refer to the parliamentary Blue-books they will find since my late father and myself, under the direction of Sir William Snow Harris, protected her Majesty's ships from lightning (prior to their being wholly constructed of iron), that the same have been free from accidents by lightning, although previously loss of life and accident had been frequent, including the loss of ships."

A Loud-Speaking Telephone.—An improvement in telephone receivers has been brought forward by Mr. W. Douglas, 63, York-place, Edinburgh, and was recently tested in that city with very satisfactory results. The receiver is to the eye of ordinary form, but inside is an electrical arrangement which produces the extra effect. To aid in the distribution of the sound, an ordinary cone speaking-trumpet is fitted upon the receiver, with the result that everyone in a room of moderate size may hear very distinctly what the telephone is saying. In the test which took place at Edinburgh, the speaker was in a cellar in the bottom of the house, but resistance coils were so arranged as to represent a resistance of from one and a half to two miles of line. At a distance of several yards from the receiver it was quite possible, says the *Scotsman*, to make out what the telephone was saying. Tunes played on a musical box were equally well heard, and sitting around the receiver all heard very distinctly the ticking of a watch. While this was so, the same telephone could at once be made a confidential agent by the removal from one hole in the box into another of a small metal peg, which turned the sound on to an ordinary receiver hanging by the side of the instrument.

Chenoweth System of Conduits.—A remarkably ingenious system of constructing conduits for drains or electric wires has been devised by Mr. A. C. Chenoweth, C.E., and has been used in constructing 4in. telephone conduits for the Croton Aqueduct at Yonkers, New York. The peculiar feature of the device is the method of forming the core in a solid concrete block laid in place. A collapsible wooden mandrel is used, made in two pieces driven apart by wedges. This is revolved, and on it is wound spirally a galvanised iron ribbon, 1in. wide, of No. 27 wire gauge, for a length of about 6ft. The trench is excavated, the mandrel placed in position, the concrete laid around it, the core being embedded therein, covered with the required thickness of concrete, and this again with earth and stone. The wedges are withdrawn and the wooden core removed, the spirally-wound iron ribbon being left as centre. Another length is laid, the ends of the ribbon riveted together, and the concrete laid as before. The ribbon remains in one continuous piece, and 10 days after laying the ribbon is withdrawn by the manholes, leaving a perfectly smooth conduit absolutely without joints. Several hundred feet of ribbon can be removed at one time. The patents covering the system are owned by the Monolithic Drain and Conduit Company, 5, Beekman-street, New York.

Poona.—At a recent meeting of the Poona Cantonment Committee, a letter was read from Mr. Rienzi Walton, executive engineer, Bombay Municipality, dealing with the proposal to light Poona by electricity. Mr. Walton considered that the offer made to the Cantonment Committee was peculiarly advantageous. There are at present 575 oil lamps of 9·5 c.p. each, the lighting of which costs at present 7,000 rupees per annum, or 1·02 per lamp per month. The scheme before the committee provides for lights of 16 c.p and at the same cost per month as the oil lamps now in use, 1·02 per month. Mr. Walton considered that an exceptionally low rate when compared with the gas lamps of Bombay of 14 c.p., which cost the municipality 6·125 per light per month. Mr. Acworth, municipal commissioner of Bombay, considered that the climatic conditions of Poona were far more favourable to electric lighting than those of Bombay, the extreme dampness of Bombay being the chief cause of high prices, and unworkable conditions in the various tenders which the Bombay Municipality had received for lighting

Bombay. He further expressed his doubt as to whether electric lighting in Poona could be undertaken on the terms specified in the cantonment secretary's minute. The matter was referred to a committee for consideration, consisting of Major Duperier, R.E., Mr. E. O. Walker, C.I.E., and Mr. Rajana Lingoo.

"Arcas" Plating.—The London Metallurgical Company has works at Turnmill-street, near Farringdon-street Station, for working a new system of electroplating known as "Arcas" plating. The operation is similar to ordinary electroplating, and is identical as regards time and current, but an alloy is used instead of pure silver or pure nickel. This alloy consists largely of silver, but its exact description is not published. On a recent visit we were shown several specimens direct from the plating bath. On emerging from the bath the material is dead-white, but on burnishing appears bright silver. The advantages are freedom from tarnishing and extreme stretching properties and plasticity, so that a flat sheet of bell metal can be easily beaten or spun into gong shape without crack or stretching marks. The new process is cheaper than silver, and is preferable to nickel-plating for several reasons. Nickel-plating is unsuitable for spoons and forks, being readily affected by acid, and being very hard, cannot be deposited very thickly. It is also porous to damp, and liable to rust off. The "Arcas" is not easily affected by acids, is elastic and has the appearance of silver. The company are also developing a new system of galvanising, the alloy using much more of lead and less of the expensive zinc than hitherto employed. This system is found much cheaper, and greater elasticity and stretching powers are obtainable. An iron galvanised rod was shown which had been bent till the iron broke, but the plating showed no "stream-lines" or signs of stretching.

Dublin.—The central station which Messrs. Hammond and Co. are erecting in Dublin is situated in the Irish Fleet-street, and will supply current to a central area comprising the celebrated College Green, and the no less celebrated Sackville-street, and to Grafton-street, Parliament-street, Capel-street, and the principal streets adjacent. Work is being rapidly pushed forward, and the mains and culverts will shortly be all in place. The system adopted is that of cast-iron pipes, 3in. to 6in. diameter, with surface boxes of a uniform pattern and interchangeable, as used in the Kensington House-to-House station. Highly-insulated cables are then drawn in. The mains comprise those for street arc lighting, in which a pressure of 3,000 volts will be used, and the primary mains for private lighting at 2,000 volts. Lowrie-Hall 100-volt transformers will be used to supply the low-tension current. The engines to be used in the central station are being built in Ireland by Messrs. Coates and Co., of Belfast, and the Lowrie-Parker dynamos, upon the latest designs, are being built in England, and will be ready shortly. It is expected to commence lighting before the end of the year. The whole of the works in Dublin are under the personal superintendence of Mr. J. W. Chisholm. Mr. Harold Dickinson has charge of the underground section, and Mr. Spencer Hawes is the Dublin secretary. Mr. Harty, the borough surveyor, whose paper upon the station recently appeared, is largely interested in the carrying out of the installation, assisted by Mr. Ruddle, clerk of works to the Corporation. Mr. Edward Manville, whose connection with Messrs. Statter and Co. has now ceased, is acting as consulting engineer to the Dublin Corporation, having offices in both London and Dublin.

Closed-Conduit Systems. — The following letter addressed to the newspapers with reference to Mr. Edison's latest discovery, has been sent this week by Messrs. Merryweather and Sons, Greenwich: "We observe that in a recent issue prominence is given in your journal to a cablegram from New York describing an alleged new system of electricity for tramways, but it would appear from the particulars given that the invention has merely secured similar results to those by the closed-conduit system, invented by Mr. John Gordon, and patented some two years ago. We hope you will allow us to call attention to the matter, as it is only fair that a Scotchman should have some of the credit for the discovery which is at present solely claimed for Mr. Edison, who can well afford to share his laurels in the matter with British talent. By the adoption of the Gordon system, storage batteries and dangerous overhead gearing are dispensed with, as the current is picked up from the rails as the car proceeds along the track, electrical contact only existing in the short section covered by the car, thereby securing absolute safety to the public traffic. A series of successful experiments have been carried out at our tramway works, Greenwich, on the Gordon system, with excellent preliminary results." The letter then describes the system, giving particulars already given by ourselves. Considering that it is now many months since we had an opportunity of inspecting the trial car, and the great influence that this firm must have in many quarters, it is rather surprising that we do not hear more of this system than letters to the papers, especially as the chief objection to the introduction of electric tramways in England has been the overhead wires. Is it not about time that an actual line on the system was equipped, and its capabilities really tested? We hope we shall hear of such an enterprise shortly, as there is great promise for a system of this kind.

Accumulator Cars at the Hague.—Six accumulator cars are now running from the Hague to the Casino at Schevening, a length of about three miles. The speed of running is 12 miles an hour, including stoppages. The loaded car weighs 16 tons; it is 32ft. long, carries 68 passengers, and the battery of accumulators weighs 4 tons. The cars, constructed at Harlem, have two bogies of two axles each. Only one bogie is driven, having its wheels coupled together. The axles are connected to the motor by solid gearing, and the whole weight is carried by the axles. The motor is supplied by carbon brushes, from a battery of 192 Julien accumulators, weighing 40lb. each. This battery, when charged, provides current for a run of 45 miles, after which the cars return for change of cells. The accumulators are arranged in eight boxes, or drawers, weighing half a ton each, placed under the seats. The car is provided with switches and resistances to allow the speed to be varied. The changing of the sets of cells is carried out by the aid of a special mechanical arrangement to allow rapid handling. Two sets of turntables and rolling carriers are placed at end of a charging bench. The drawers, when taken from the car, slide easily on rollers placed on the bench and turntables, the operation of changing requiring five minutes. The spare sets of cells are always being charged as the others are being used. The connections are made with spring contacts arranged so that no mistake can occur. The charging is accomplished by means of Silvertown shunt dynamos, with hand regulators, giving 60 amperes at 100 volts. The machine-room contains two condensing steam engines of 210 i.h.p. each. The condensing water is supplied by a syphon from the canal three-quarters of a mile away. The installation is completed by a small workshop driven by an electric motor, itself supplied by a small battery of 70 cells of 66lb. each, which are also used for lighting by means of 10 arc lamps. It is intended to settle the question of maintenance by the erection of a small manufactory of battery plates on the spot, with a laboratory.

SHIPLIGHTING BY ELECTRICITY.

(Continued from page 392.)

Fittings.—The tendency nowadays is to reduce the number of varieties of fittings as much as possible, as it makes repairs easier.

The following is a list of the fittings which are found necessary: (1) pendants; (2) brackets; (3) cage pendants; (4) cage brackets; (5) roof lights; (6) saucer lights; (7) sconces; (8) hand lamps; (9) cargo lights; (10) gangway lights.

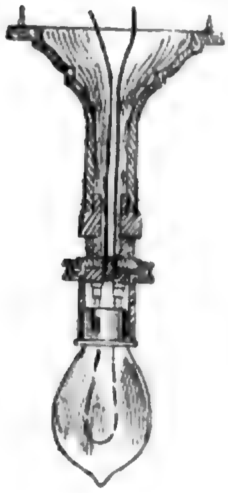


Fig. 5.—Pendant on 2-wire System.

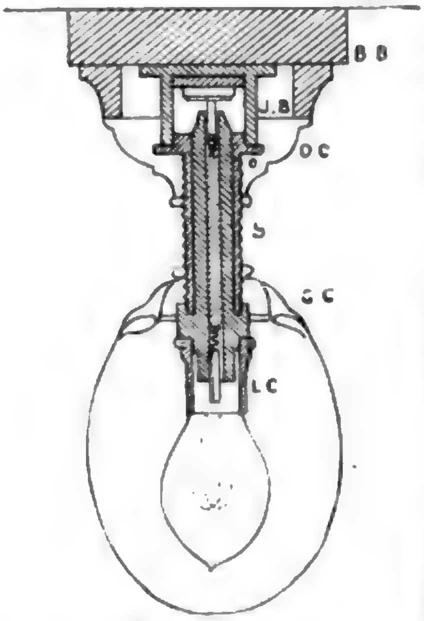


Fig. 6.—Concentric Pendant.

These may be either lacquered brass, bronze, or electroplate. The pendants are intended for saloons, cabins, etc., and are generally fitted with pear-shaped opal globes. The cage pendants, which are used in the engine-room, crew's quarters, etc., are similar to the pendants, the principal difference being that they have plain glass globes, with strong wire cages over them to protect them. The brackets and cage brackets are simply pendants and cage pendants with the stalks bent at right angles, and are intended for fixing on the bulkheads where it is not convenient to fix them on the roof. Roof lights are intended for the cargo spaces in the 'tween decks, and are made so that they can be readily unscrewed, and solid covers screwed on as a protection from cargo.

Saucer lights, which are intended for bulkheads where one light is used for two places, consist of two saucer-shaped glasses, with metal rims; a circular hole is cut in the bulkhead, the lampholder is fixed in the centre, and the glasses are fastened on each side with screws. Sconces are used in exposed places—such as on deck—and also in the engine-room. They are generally fixed to the bulkheads, but may be also fixed to the roofs. Hand-lamps, as their name implies, are for carrying about, to allow which a length of twin flexible leads is attached to them. They are exceedingly useful for examining machinery, looking in cupboards, etc., and are always in great demand. Cargo lights consist of umbrella-shaped metal reflectors, in the centre of which a group of small lamps, or it may be one large lamp, is fixed. Though the latter is most economical, the former is preferable, as in the event of one lamp being broken, you have the others to go on with. These also have flexible leads attached to them, which, when they are required, are fixed to couplings provided for the purpose in convenient parts of the ship. They are intended to be hung over the centre of the hatchways when cargo is being discharged. Gangway lights are large lamps, with glass globes and cage protectors, made to hold three or four small lamps, and are intended to hang over the ship's side to give light to the gangways. They are attached in the same way as the cargo lights, but they are not always used, as the former may be made to answer the same purpose. To this list we may add electroliers, one generally being fitted in each ship. The number of varieties of these is endless. Simple designs, however, are the most satisfactory, as they are easier to keep clean, and stand the working of the ship best. All these fittings may be used with either double or single wiring. With double wiring the wires are drawn through a tube into the lamp when it is being erected, and attached to the lampholder by means of screws. Besides the danger of injuring the wires when drawing them in, there is also a liability of water getting into the tube afterwards and corroding the fitting. The single-wire system has the advantage, that should it become necessary to take down the fittings this can be done in a few minutes, leaving the wires undisturbed. Fig. 5 shows a pendant on the two-wire system.

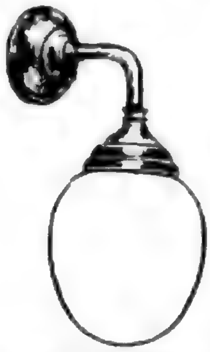


Fig. 7.—Bracket.

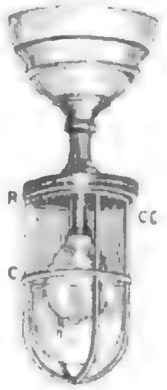


Fig. 8.—Cage Pendant.

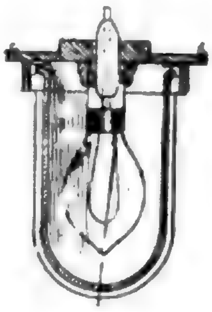


Fig. 9.—Roof Light.

Fig. 6 shows a watertight concentric pendant, as used in the single-wire or concentric system. On screwing the stock into the junction-box the spring plunger, S P, at the top makes contact with the button of the screw junction, and assuming, for the sake of convenience, that the current flows down, it passes from the junction to the plunger, down the central metal rod, through the spring plunger at the bottom, to the central contact of the bulb, through the carbon filament, up the stock of the lamp to the junction-box, through the small fuse and earth wire, to the hull of the ship.

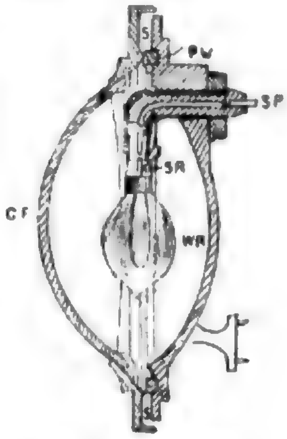


Fig. 10.—Sconce.

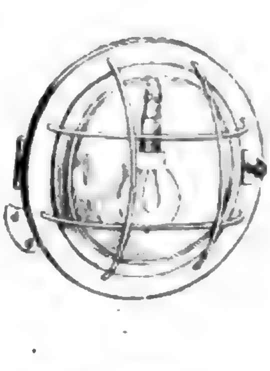


Fig. 11.—Sconce.

Fig. 7, which represents a bracket, is similar to the pendant, except that it is bent at right angles. The cage pendant, shown in Fig. 8, is also the same as the latter, except for the globe carrier, G C, which is soldered to the stock. The rim, R, is screwed inside, a rubber washer being inserted, so that when the globe, G, is put into place and the cage, C, screwed hard up, the whole fitting is thoroughly watertight.

Fig. 9 is a roof light.

Figs. 10 and 11 show a section of a sconce and a complete view. The connection is made by the three spring plungers, S P. The front has a hinge on the right side and a screw on the left. W R is a white enamel, or mirror, reflector, round the edge of which a rubber washer, R W, of square section is placed in a suitable groove. When the lamp has been fixed and the front is closed, the shoulder on it, S, bears on the rubber washer, and when the screw, *s*, is entered and screwed up tight no water can possibly get in.

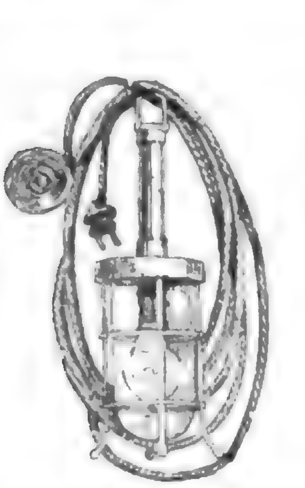


FIG. 12.—Hand Lamp.

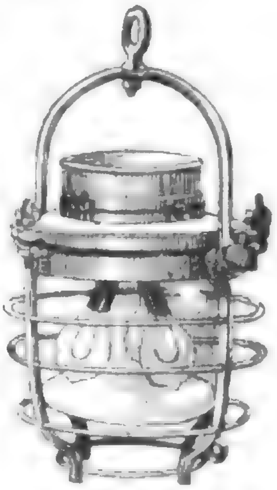


FIG. 13.—Gangway Lamp.

Figs. 12 and 13 are hand lamps and gangway lamps, and Fig. 14 is a section of a cargo reflector. It consists of a metal shade, to which the brass bowl reflector is attached, the whole, together with the stock, forming part of the return. Inside is a metal rim, insulated from the shade, and from this an insulated wire is led to the centre contact in the gooseneck. Round the bowl, holes are bored and tapped to receive the lampholders, being so placed that when the latter are screwed home their contacts bear on the insulated rim. The fixing of the holders is thus rendered very simple, and a great deal of time is saved.

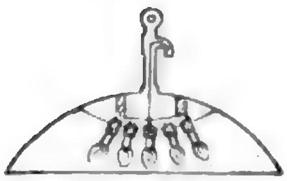


FIG. 14.—Cargo Reflector.

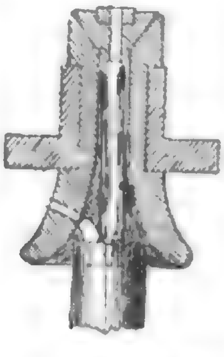


FIG. 15.—Concentric Swivel.

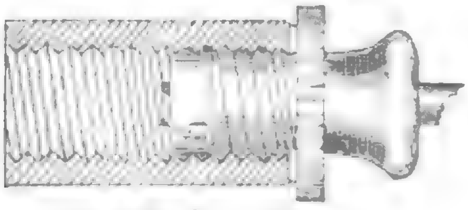


FIG. 16.—Junction Sleeve.

The flexible lead may be either twin wire or concentric wire. To each end of it a concentric swivel is soldered as shown in Fig. 15, and by screwing this into the gooseneck, and into a junction-box provided for the purpose, connection can be made in a few moments. By means of brass sleeves Fig. 16, any number of these leads can be joined into one, which in many cases will be found very convenient. This concludes the fittings which may be considered necessities. Others may be added, or those mentioned may be made more ornamental according to the fancy of the owner.

In conclusion, I may say that people are sometimes inclined to expect an electric light installation to look after itself. This is expecting too much, and no installation, no matter how well it is designed and carried out, will give satisfaction if it is not properly looked after.

BRITISH ASSOCIATION CARDIFF MEETING.

JOINT DISCUSSION ON UNITS BY SECTIONS A AND G.

DR. OLIVER LODGE: There are a good many things to be said about units at the present time, both mechanical and electrical. I think it will be for the convenience of the section if at the beginning of the discussion we attend principally to the electrical units, and to those units which are of established interest to engineers, and leave the more academical and mechanical units to a later period. With regard to electrical units, one of the most pressing things is the determination of an authoritative statement or agreement as to the coefficient of induction—not only self-induction, but also mutual induction. Now, we know that already a great many names have been suggested for this unit. The mere name of the unit is, of course, very unimportant from some points of view, but it is not wholly unimportant whether this unit shall be called secohm or quadrant, or by the name of some man. Henry, mac, and other names have been suggested. The name secohm has certain advantages, in that it indicates the relation between this unit and the ohm-second, but there are certain disadvantages in that it tends to express the more simple by the more complicated. It expresses the unit self-inductance as being derived from the ohm, whereas the determination of the ohm itself is based upon a measurement of inductance; instead of describing the self-inductance unit as an ohm multiplied by a second, it would be more logical to call the unit of resistance a self-inductance divided by time. In all methods of determining the ohm, some form of coefficient of induction is the length that enters into the expression. If it is to be called a quadrant, it must be remembered that a quadrant is strictly an angular measure; and even though it be understood as short for earth-quadrant, and therefore a length, still it is not unobjectionable, for it is pretending a thing to be a length when it really is not a length. I think it would be a backward step if we fix it for all time as a length. On the whole I should suppose that some name of less obvious meaning might be desirable, such as the name of a man. Now directly we permit ourselves to regard the name of a man as a possible name to be attached to the unit, we have the field open to consider. We are no longer compelled to make it equal to a secohm: it may be a sub-multiple. Now let us consider whether the secohm is a convenient size. The C.G.S. units were a connected system, or might have been a connected system, before any practical units were invented. Practical units were invented for this reason, that C.G.S. units were not a reasonable size—they were a million times too big or too small. It was out of the question for engineers to be always speaking of powers of ten. Now a secohm is rather big for a practical unit. Very few people—I speak under correction—have to deal with coefficients of induction of more than a secohm. The question is whether it would not be better, therefore, to make our practical unit some sub-multiple, say a thousandth, or something of that sort. We have a consistent system in the C.G.S.; there does not seem adequate need for two consistent systems. I regard it as more important to have the practical units of convenient size, than to have them most simply related among themselves. The farad has been useless, by reason of the neglect of this idea. The whole object of a practical system is to have units of convenient size, otherwise the C.G.S. would be all that is necessary.

The next unit wanted is a practical unit of magnetic field, or the unit of magnetic induction. Let me just explain what I mean by a practical unit of magnetic field. There is a C.G.S. unit—and it has not at present had a name given to it, although sometimes names are used—but it is too small for engineering purposes; it is something comparable to the intensity of the earth's magnetism. The total intensity of the earth's magnetic field is about half of one of these units. The magnetic fields with which engineers have to do are usually enormously greater, hundreds or thousands of times. Moreover, the definition of C.G.S. magnetic field is not one which immediately applies to engineering practice. We do not deal with a unit magnetic pole; and although it serves fairly as a fundamental unit for theoretic purposes, it is not very practical. Now consider how magnetic fields do come in; they come into engineering practice in the case when you have a coil of wire rotating in such a field. You have a certain area through which a number of lines of force pass; each complete revolution of an armature coil cuts the total lines of force four times, and the voltage which you can get is just equal to the rate of cutting those lines of force. That is to say, if N represent the total number of lines of force passing through a coil, what would be called total magnetic induction through the coil, and if

$$e = \frac{d\,\mathrm{N}}{d\,t},$$

this gives the voltage; of which the value at any instant is the rate of the change of the magnetic induction. That is the fundamental formula of magneto-electricity. It contains almost the whole philosophy of the dynamo. Here is another formula which contains the whole philosophy of motors.

$$d\,w = \mathrm{C}\,d\,\mathrm{N}.$$

The work done during any operation is equal to the current multiplied again by the change in the magnetic induction, the power being $\mathrm{P} = e\,\mathrm{C}$. It would seem as well to have some practical name for this quantity, N, so constantly occurring, the total lines of force, or the magnetic induction. As for magnetic field, that is related to this quantity in the simplest possible way; for it is the number of lines of force through unit area.

Whether the name shall be given to intensity of field or to magnetic induction—there might be a name for both—the relation between them is quite simple. The important thing to point out in most cases in practice is, that N is related to the coefficient of self-induction in a very simple manner. Suppose you have a closed solenoid, sectional area A, length l, permeability μ, number of turns n, the total magnetic induction caused by a current, C, in that solenoid is:

$$\mathrm{N} = \frac{(4\,\pi\,\mu\,n^2\,\mathrm{A})}{l}\,\mathrm{C}$$

It merely requires a slight modification to make it applicable to dynamo magnets and other things. I only quote the expression in its simplest form. There are more complicated similar forms, but in all cases the induction caused by the coil's own current, or the true "self-induction," is equal to something multiplied by C; and that something essentially is the coefficient of self-induction, or the inductance, a thing which is commonly denoted by L. So the above expression is simply $\mathrm{N} = \mathrm{L}\,\mathrm{C}$. Hence, if we have a name for the coefficient of self-induction, we have a name at once without any trouble for the total magnetic induction through an area.

I do not wish to call it any particular name, but supposing mac were the unit of self-inductance, then the unit of current being an ampere, the unit induction would be a mac-ampere; thus we should have a name at once for the total magnetic induction, and when you want to express the intensity of a field it would be a mac-ampere per square centimetre. Another name for unit induction is a sec-volt, which is plainly equal to a secohm-ampere, or, as I have just called it, a mac-ampere. Perhaps sec-volt is a good name; of course, it is the number of lines of force which if cut in one second gives, in the cutting circuit, an E.M.F. of one volt.

Mr. W. H. PREECE said the work of the British Association Committee on Electrical Standards has now extended over thirty years. Its first report was issued in the year 1861, at Manchester, and we have, after a great deal of difficulty and trouble, succeeded in impressing those units of measurement, not only upon the scientific world of England, but upon that of all countries. During this last year, a committee appointed by the Board of Trade has taken into consideration the work of the British Association Committee and has come to the conclusion which will result, in the month of November, of an order in Council being passed making the ohm, the volt, the ampere, and the farad legal standards, such as will for years to come be regarded as the stable standard measurements in England. Now having run in a groove for 30 years, and having succeeded by dint of great labour in impressing these units on others, I am afraid we are running our heads against a brick wall when we attempt to produce any change upon such a system. Nevertheless, while the difficulty of producing a change is very great, I am going to have the temerity of suggesting a change in another direction, in addition to that suggested by Dr. Lodge. While there is a difficulty in making a change, there is also a difficulty in impressing new ideas into our language, even when absolutely essential. New wants arise and we must have new names to express these new things. The fashion to introduce new meaningless words has practically failed. They tried to thrust upon us the term barad as indicative of the standard of pressure, bole the unit of momentum, and kine the unit of velocity, but I think this attempt has practically failed, and I have met but one case where one of these names was used, and then it was spelt wrong. I am a great advocate for the use of words based on names. They enable us to pay a graceful compliment to those who have passed away. They enable us to attach a useful word to something that requires great precision of thought. The use of such words as ohm and volt and ampere almost render definition unnecessary, and in some cases they remove great difficulties, for I am sure if there was a mistake made by students and by professors sometimes, it was in drawing distinction between "power" and "work." Now we have introduced two words, watt and joule—watt as the unit of power, and joule as the unit of work; and I think I can confidently state that nobody since the introduction of these words has made the mistake of confusing power with work or work with power. So, I say, words clearly indicating these standards are very useful and valuable. We have several names from which we might draw. We have Gilbert, we have Gauss, we have Weber, we have Franklin, Henry, Maxwell. These names are valuable, and certainly there are some units to which they might be very well applied. I have mentioned the names of men who are dead, for I think it would be unwise to affix the name of the living, and though there is one whose name will be associated with the electrical units some day, it is perhaps better for the present to stick to the dead. There are more names wanted still. Prof. Lodge has alluded to the unit of magnetic field or force, and there is not the slightest doubt that the time has arrived when we must adopt the unit of magnetic field, and we must give that unit a name. Some have proposed that this unit shall be based on the C.G.S. unit alone, others have suggested that it should be 10 to the power of 8, and I am going to propose that it should be called 10 to the power of 9. The reason why I suggest that change is dependent on another alteration that I am going to suggest, that the volt should be 10 to the power of 9 instead of 10 to the power of 8. That matter is dealt with in a paper by Prof. Stroud, and I would rather adhere to this point only now, because he will in his paper deal with the matter very thoroughly. Ten to the power of 8 was selected by the original committee solely because 10 to the power of 8 was the nearest approach that we could find to the Daniell cell. That cell was then universally applied, but it is now surpassed by others such as the Leclanché or bichromate, the E.M.F. for which is much higher. One great reason why I propose that the value shall be 10 to the power of 9 is, that it makes the farad the same in C.G.S. as in practical units. I should very much like to have said something on dimensions, but I want to refer to one other unit that requires to have a name attached, that is H. There was a time when there was a great demand for unit magnetic pole, but that time has long since passed, and Dr. Lodge himself has referred to induction as N, more particularly in its form per square centimetre, and called B density of field. There are two great quantities that are most important in electrical developments of the present day, and that require a great deal of sifting—not that we can find units for them—one is μ, the other the coefficient of specific inductive capacity, sometimes called K, then we come to L, the coefficient of self-induction. I have said that there is more nonsense talked about self-induction than any other branch of electrical science. There are those who talk about self-induction who have had very little practical experience of its effects, who have applied self-induction sometimes to a geometrical quantity, sometimes to permeability, and sometimes to the whole induction. It has been my practice for some years never to speak of self-induction, because it is mixed up so dreadfully, but always to speak of electromagnetic inertia, and that is the term we have met with in practice which is familiar to us. When we find writers misusing this term self-induction, it makes one regret that we have not a unit for it so as to centralise one's ideas and to avoid friction. I am at one with Dr. Lodge when he proposes a unit of self-induction. Nobody has proposed a better name than that of "henry." 10 to the power of 9 is a very good unit indeed, and if we had this unit 10^9 we could wipe out the use of the word secohm. The system of units now used is absolutely artificial and conventional. I will not occupy your time with dealing with the relations between H and various other quantities. The name of Gauss has been proposed; in fact, it was proposed in Paris. If there are two men whose names ought to be used as units, one is Gilbert and the other Gauss, who have done so much to establish the absolute system. We want to know the value of K and R. Perhaps Prof. Rücker, who has worked in this direction, will do something more. We want something more than dimensions; we want a table of specific resistances. At the present moment we have really only the specific resistance of mercury and of copper accurately determined. We also want a new determination of J, and a better mode by which the mechanical equivalent of heat can be arrived at. We want to get rid of the obnoxious table of dimensions that every text-book is laden with. In Maxwell's great work there are three or four different systems of dimensions, and in engineers' pocket-books, which are supposed to contain useful facts, pages after pages are filled with these useless dimensions.

In conclusion, the speaker said he should be very sorry if any decision that this section should come to should interfere with the acceptance of the ampere, ohm, and farad as the legal standards. If it were to go abroad that they were disunited it might perhaps tend to the withdrawal of the order in Council. He thought that certainly this year these standards would be made legal, and then these standards would be the legal standards of the world.

A paper was then read by Prof. W. Stroud on

SOME REVOLUTIONARY SUGGESTIONS ON THE NOMENCLATURE OF ELECTRICAL AND MECHANICAL UNITS,

of which the following is a summary.

Present Practical System of Units.

1. The present practical system of units is very objectionable on three grounds:

(α) There is no *primâ facie* reason why the practical unit of current should be equal to $\frac{1}{10}$th C.G.S. unit.

(β) The relation between the other practical electrical units and the corresponding C.G.S. units is much more complex than need be.

(γ) The units of work and power are far too small for practical requirements.

2. If we were starting to devise a practical system to-day, such a system could best be formed by taking 10^{-9} cm. as the unit of length, 10^{-9} gr. as the unit of mass, and the second as unit of time.

3. That in the interests of the "practical" men of the future and in the interests of the electrical students of both the present and the future, it is highly desirable to institute a revolution with the object of dethroning the present practical system of units.

Nomenclature.

1. That the term dyne to indicate 10^7 of our present (1891) dynes is objectionable, as custom has restricted the use of Greek derivatives entirely to C.G.S. units. That 10^7 dynes, if required, should be called a hebdomodyne, suitably contracted of course, or preferably a joc (joule over centimetre).

2. That the classical languages are of little or no service for the provision of names for modern, more or less complex, physical conceptions; and therefore this method of coining words it is desirable to abandon.

3. That for C.G.S. units some system of automatic nomenclature, in which every name shall be self-explanatory, would prove a boon to the teacher and a blessing to the student, and that such a system is quite capable of being devised.

4. That the prefixes *meizo*, to indicate 10^9, and *mei*, to indicate 10^{-9}, may be found useful.

Mr. **Swinburne** said he was rather inclined to think it would be better to stick to the old units. He did not think Section A realised the enormous difficulties that they put in the way of practical people by making alterations. The alterations in the ohm would produce a great deal more trouble than was yet realised. He might say with regard to self-induction that it would not spread much in practical work. His firm made a large number of transformers, and it was necessary to make these with great accuracy, but he did not believe anyone in his place could tell in secohms what the self-induction of any transformer was. In regard to names, he would hope that the name of Poggendorf would not be left out.

Dr. **Johnstone Stoney** said on this question, at the present day, he was a complete conservative. He would wish to see the ohm system of measurement maintained intact, and he believed that only practical mischief would result from any attempts now to diverge from the ohm system. He was a member of the committee which fixed the C.G.S. system of measurement recommended in 1874, Prof. Carey Foster being another. On that committee there were some members who had long practical acquaintance with the metrical system of measurement, but there were other members who had only immediately before been converted to the opinion that the systematic system of units ought to be based on metric measures, and who had had little practical acquaintance with it as a working system. He (the speaker) dissented from the selection that was made on grounds totally different from those attributed to him in Prof. Everett's book. He would wish to take this public occasion for stating that the original note which Mr. Everett put in the first edition, and the subsequent note in the second edition, did not in the least represent what he stated at the committee. No systematic system of units could have been framed without some electrostatic and electromagnetic units belonging to it being inconveniently large or small; but it was quite unnecessary to make a selection which led to the same defect prevailing among the dynamical units. What he (the speaker) had objected to was choosing such fundamental units as led to a unit of force so inconveniently small as the dyne (about the weight of a milligram), a unit of energy so small as the erg (about the hundredth-thousandth part of a grammetre), and a unit of power which is the ten-millionth part of the watt. The definite proposal he made to the committee was, that the metre should be the unit of length and the kilogramme of mass; but he would have concurred in recommending any selection of fundamental metric units which would have led to convenient dynamical units. With respect to the unavoidable size and minuteness of some of the electrical units, he suggested that a nomenclature should be introduced which would make it easy to use in practice any decimal multiples or submultiples of them. For instance, they had got the farad, a unit of capacity too large for any practical purposes. Accordingly, the practice was to make use of the microfarad, as it was unfortunately called. He would prefer to call it the sixth farad (the farad divided by 10^6). It is a very convenient measure for measuring the capacity of submarine cables, and in cases where large capacity had to be dealt with; but if they wanted to measure the capacity of an ordinary Leyden jar it would be a great deal better

STONEY'S TABLE OF THE RELATIONS BETWEEN ELECTRIC UNITS.

—			Dynamical dimensions.	Electrostatic dimensions.	ELECTROSTATIC.				MAXWELL, Unit of	ELECTROMAGNETIC.				Electro-magnetic
					C.G.S. Unit of		Ohm Unit of				Ohm Unit of		C.G.S. Unit of	
Quantity.		*Of Magnetism…	…	α	**p′**	10 >	**p**	=	**p P**	30 >	Gilbert	10^8 >	**P′**	
		*Of Electricity …	…	$v\,\alpha$	**q′**	10^8 <	**q**	30 <	**q Q**	=	Coulomb	10 <	**Q′**	
		Of Mass ………	$\frac{\alpha^2}{L}$	…	**m′**	10^{11} >	**m**	30 >	**M**	…	…	…	…	…
		Of Volume ……	L^3	…	**b′**	10^{27} <	**b**	30^3 <	**B**	…	…	…	…	…
*Electric current ………………			…	$v\,\beta$	**a′**	10^8 <	**a**	30 <	**a A**	=	Ampère	10 <	**A′**	
Energy factors.	Potential at each point of space.	On Magnetism…	…	$v\,\beta$	**v′**	10^8 <	**v**	30 <	**v V**	=	**V**	10 <	**V′**	
		*On Electricity…	…	β	**v′**	10 >	**v**	=	**v V**	30 >	Volt	10^8 >	**V′**	
		On Mass ………	v^2	…	**V′**	10^{18} <	**V**	30^2 <	**V**	…	…	…	…	…
		On Volume ……	$\frac{\beta^2}{L^2}$	…	**V′**	10^{20} >	**V**	30^2 >	**V**	…	…	…	…	…
Force factors.	Potency at each point of space.	*On Magnetism…	…	γ	**g′**	10 >	**g**	=	**g G**	30 <	Gauss	10^{10} <	**G′**	$\frac{\gamma}{v}$
		On Electricity…	…	$\frac{\gamma}{v}$	**g′**	10^{10} >	**g**	30 >	**g G**	=	**G**	10 <	**G′**	γ
		On Mass ………	$\frac{v}{T}$	…	**g′**	10^9 <	**g**	30 <	**G**	…	…	…	…	…
		On Volume ……	$\frac{\beta^2}{L^3}$	…	**g′**	10^{29} >	**g**	30^3 >	**G**	…	…	…	…	…
Tubes of Force [the number of which per unit area = Potency]		*Magnetic………	…	$v^2\,\alpha$	**n′**	10^{17} <	**n**	30^2 <	**n N**	30 >	**N**	10^8 >	**N′**	$v\,\alpha$
		*Electric ………	…	$v\,\alpha$	**n′**	10^8 <	**n**	30 <	**n N**	30^2 >	**N**	10^{17} >	**N′**	$v^2\,\alpha$
		Mass …………	$v^2\,L$	…	**n′**	10^{27} <	**n**	30^3 <	**N**	…	…	…	…	…
		Volume ………	$\frac{\beta^2}{L}$	…	**n′**	10^{11} >	**n**	30 >	**N**	…	…	…	…	…
Electric.		*Resistance ……	…	$\frac{1}{v}$	**r′**	10^9 >	**r**	30 >	**r R**	30 >	Ohm	10^9 >	**R′**	
		*Coefficient of self-induction	…	$\frac{L}{v^2}$	**s′**	10^9 >	**s**	30 >	**s S**	30 >	**S**	10^9 >	**S′**	L
		*Capacity ………	…	L	**c′**	10^9 <	**c**	30 <	**c C**	30 <	Farad	10^9 <	**C′**	$\frac{L}{v^2}$
		*Specific inductive capacity	…	O	**k′**	=	**k**	=	**k K**	=	**K**	=	**K′**	0
					E [Voltage, or electromotive force], identical with potential *on electricity*.									

In the columns of dimensions $\alpha = \sqrt{L\,M}$, $\beta = \frac{\sqrt{L\,M}}{T}$, $\gamma = \frac{\sqrt{L\,M}}{T^2}$. The units of L, M, and T for the Maxwell column are so selected that the unit of v becomes in it the velocity of light, and that the units of α, β, and γ remain the same as in the ohm columns.

* Asterisks are introduced to direct attention to the more important of the horizontal lines.

to measure it in tenth farads instead of sixth farads. This nomenclature would enable one to use the tenth farad when convenient, and the sixth farad when convenient, and would tell exactly their relation to one another. To deal with multiples, and in order to make the distinction between sub-multiples and multiples as great as possible, he proposed that the tenth metre should mean sub-multiple, and that the metre-ten should mean multiple, and so on. That system of dealing with the multiples and sub-multiples would be a very great practical convenience to electrical engineers. It would also avoid entirely the necessity of following what, he understood, was the suggestion of the president, of using a unit for self-induction which did not belong to the ohm system. He certainly thought it would be a very retrograde step for the B.A. to abandon the fundamental principle of making all the measures belong to some definite systematic system. It was a misfortune that such a thing should occur as was mentioned by Mr. Swinburne, that artisans who were habitually engaged in making transformers could not tell in the least, in any definite system of measures, what the self-induction was. He believed it would be a very great increase of their capacity fordoing real work if the use of measures at every stage was so facilitated that every artisan could have a clear perception of the measures he was using. Personally he was averse to any revolutionary change, and although the C.G.S. system he believed was not the best that could have been selected, he should be sorry to see it interfered with in any degree now. He proposed an obvious and easy method for converting from electrostatic into electromagnetic measures. There was no doubt, for some purposes, electrostatic measures were more convenient to work. At present engineers were practically precluded from doing so in a case where it would give them a great deal of assistance, by the difficulty of easily tracing the relation between the two. Mr. Preece seemed to have a great objection to dimensional equations. He (the speaker) on the other hand, would wish to see dimensional equations made so simple that they would come into very general use. The speaker here referred to a table, given herewith, which was intended to facilitate the conversion of electrostatic into electromagnetic measures. The units in the central column of this table had been introduced, not with any intention of recommending the use of a new set of measures, but only as the natural bridge between electrostatic and electromagnetic units, which assisted the conversion of these into each other by making clear to the mind the numerical relation between them. He thought that the natural name for the unit of magnetism would be the

Gilbert, he being the first man they could trace who had really studied magnetism, and the natural name for the unit of magnetic field would be Gauss. Poggendorf and some others had been mentioned, though if any name deserved the distinction, it was that of Weber, who was the first person to point out the importance of systematic units. There might be a difficulty in the way of this on account of the pronunciation. He would also very earnestly try to persuade the members of both Section A and Section G to the opinion that the time had fully come for getting rid of the dreadful misuse of the word force, as in the phrases electromotive force, magnetic force, etc. The speaker, in conclusion, said he did not like the word pressure: it suggested a misleading analogy. He saw no objection to the word voltage, which was very convenient for practical use and got rid of the false analogy.

Prof. CAREY FOSTER expressed his satisfaction at hearing the expression of Dr. Johnstone Stoney's conservative principles in the matter of nomenclature. If they were to have new standards they must employ a new name; they might employ a term derived from "Galvani," say "galv" or "gal."

Prof. SILVANUS THOMPSON said, in relation to the unit of self-induction, that Dr. Lodge had stated that he did not see why its coefficient should be considered as a length, but it was a length, and Sir William Thomson had devised an ideal experiment illustrating the point. They needed that a physical fact should be discovered to enable them to determine the absolute value of k or μ.

Prof. T. H. BLAKESLEY wished to introduce to the section a unit with which he had been greatly concerned; this was the particular one which was measured when a current was sent through one coil of a dynamometer, and another current through the other. It was the product of two currents. It was most important to arrive at the power per unit of resistance. At the Physical Society he had given many cases in which the application of the split dynamometer would be the most advantageous, and in some cases, such as the power lost in the revolutions of magnetism in the iron core of a transformer, it was practically the only way to arrive at it. He was very averse to giving the names of people, however eminent they might be, to units.

Prof. ANDREW GRAY thought the phrase "electromotive force" was unfortunate, but that it would cause much inconvenience to drop it. A clear distinction, ought, however, always to be made between E.M.F. at a point (that was, the electric force) and the E.M.F. round a circuit. It would cause serious confusion if one word were used in two senses; if the word "force" was not used alone, but was described at the time of speaking, he did not think much disadvantage would arise. He trusted that more attention would be given to what was of greater importance than finding a name for the unit of inductance—viz., the calculation of coefficients of induction.

After a few remarks from Prof. J. V. JONES, The PRESIDENT stated that time would not allow of the continuation of the discussion; he hoped that it would be continued in the journals, especially as at present it was not quite clear what was actually wanted in practice.

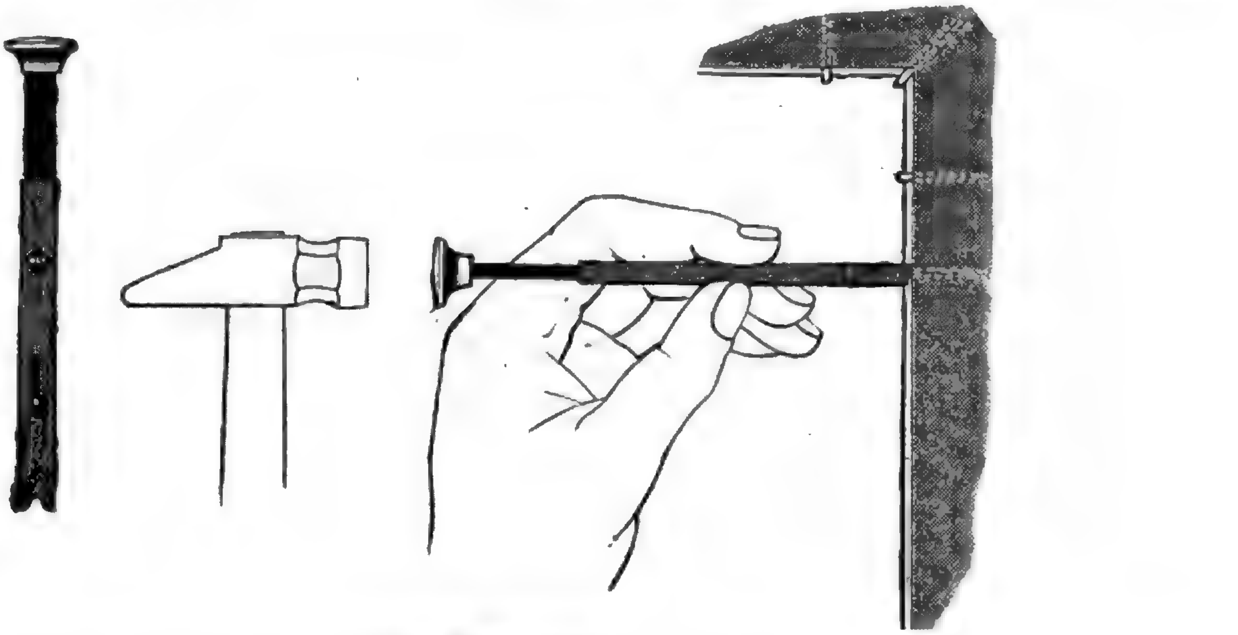
Mr. PREECE thought that it would be objectionable for the British Association to suggest any change in the principle of the unit. The farad was as immense as the universe, and the microfarad very small, but useful; he thought that it would be well to call the microfarad the farad, and that they should call the volt and ampere either the 10-volt and 10-ampere, or the weber.

A STAPLE-DRIVER.

Those who have had much experience in running bell wires have often wished for some easy method of holding staples in position without using their fingers for the purpose.

We illustrate a simple little instrument, which has been designed with this end in view. It holds the staples in position until they have penetrated far enough to be driven home with the hammer.

The tool consists of a rectangular tube of a size suitable for the staples being used, in which is a plunger with a movement of about ½in. The staple is placed in the end of the tube, when it is held, and the projecting points are placed over the wire which is being run. A blow is then given to the opposite end of the plunger, after which the tool is removed and the staple driven home.



New Staple-Driver.

It will be found very handy for those who are in the habit of running wires overhead, or in other places where it is inconvenient to hold the staples in the fingers.

The tool may be obtained of Messrs. Woodhouse and Rawson United, Limited, 88, Queen Victoria-street, E.C.

Search-Lights in Shipwrecks.—Recent disasters have called forth the suggestion that electric flash-lights on the coast should be rendered available in case of shipwrecks by night, and the special case has been mentioned that the lights under the control of the Tyne Submarine Mining Engineers should thus be used in the event of wrecks at the mouth of the Tyne. A local correspondent with reference to the magnificent flash-light at Cliffords Fort, asks: "If we use the most powerful light we have to search for our enemies, why not use the same to search for our friends who may be in peril?" He suggests that the plant at the fort might send the power both to Tynemouth and South Shields Life Brigades, where the largest and most powerful light would prove of the greatest service. At any rate he thinks it would be worth trying, as no experiments would be wasted that would in any way assist such heroic efforts as were made at Tynemouth at the wreck of the "Peggy."

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LEEDS AND OVERHEAD WIRES.

It has required the enterprise of an American firm to introduce the first electrical tramway worked with overhead wires into England. The prejudices of Englishmen against overhead wire are the outcome of a cautious temperament. It is recognised that such wires are unsuitable in our larger towns—at any rate in the more thickly-populated towns with narrow streets. America, with its wider streets, may tolerate what would be condemned here, for it must always be remembered that the central, and ofttimes the busiest, parts of our towns consists of narrow, tortuous streets, wherein traffic is congested, and in which there is not an atom of room to spare. In the suburban districts and in country districts, however, there seems to be no insuperable objection to overhead conductors. The electric tramway just formally opened at Leeds runs through a district not unsuited to overhead conductors. Roundhay Park is to be the playground of Leeds; it is some miles from the busy centres of the town, and a long stretch of the tramway running to Roundhay is through a very sparsely-populated district. New houses are being rapidly built at some points along the route, but between these and Roundhay the right-hand side of the road, at any rate, looks out upon more or less open country. The through traffic upon the tram line during the winter months, except perhaps at certain hours morning and evening, will not be very great, but the summer traffic should be heavy. This fact may be desirable, inasmuch as it will allow the managers of the tramway to thoroughly test all their apparatus during the portion of the year that traffic is least, so that it may be in a perfect state of efficiency when the spring comes and the pleasure traffic commences.

It does seem peculiar, though, that Leeds should go to America for machinery, yet to those who know aught of tramway work the singularity will not be noticed. We know of no English firm of tramcar builders, for example, that pushes its wares like the Americans, and it is almost certain that the greater part of tramway rolling-stock has been supplied by America. There may be a reason for this in that the woods principally used are from typical American trees. In America, as has been so often explained, overhead electric trams are common. Not only so, the system has quickly caught on, and seems destined to become the ordinary system of the States. American electrical engineers could not understand the difficulty of adopting electric traction in this country, hence the Thomson-Houston Company sent over Mr. Graff Baker to exploit their system here. We vividly remember Mr. Baker's call upon us soon after his arrival in this country, and the assertion he made that he would have a line running ere he was eighteen months older, to show us benighted folks what could be done. He has got his line, though we are not quite sure that it is within the time mentioned. The result has not been easily obtained. More than one scheme that promised to lead to an installation has had to be abandoned, but the opportunity came at last, and the line is equipped. It is unnecessary to enter into the history of the Roundhay tramway, but we may say that it offered a much better opportunity for electric traction than almost any other line in the kingdom. We have often pointed out that many different conditions in the States have lead to the introduction of electric traction. Here mileage is almost at a standstill, there it is rapidly increasing. It is the new lines in America that patronise electricity to the greatest extent. Here the permanent way *is* laid, the initial capital spent, and the only question for the management is to earn dividends. To change the system of working means, in most instances, increasing the capital to carry out the necessary alterations. We are therefore in this position: Most tramways are, under existing conditions, earning a fair dividend; they are promised a *probable* increase, if they will change their system; but, on the whole, they say, "A bird in the hand is worth two in the bush." We are quite sure that electric traction is the best means of working our tramlines; but who will provide us with an argument to combat the "bird-in-the-hand" view? Prominent tramway men have again and again said to exploiters of electrical systems who have urged the adoption of their pet system, "Yes, what you say is all very well, and here is our offer. You say the cost of working your system is so-and-so. We will hand you over our lines to work, providing you will pay us such and such a rate. According to your own showing that will leave you handsome profits." In other words, the managers cynically say, "Have the courage of your convictions." There are one or two cases on record where this courage has led to a contract; but as yet nobody outside the inner management of the contractors knows the true state of the balance-sheet. What they can see, however, is that the contractors are in no hurry to increase their contracts. The Roundhay tramway differed widely from these dividend-earning tramlines. There were the lines, but they were unused. There was no man in possession, so there was no existing equipment to put aside. Hence the advantage to electrical enterprise, and electrical enterprise has taken hold—with what result the future must say.

THE LONDON ELECTRIC.

The various rumours concerning the London Electric Company are in most cases the outcome of an excited imagination. Fortunately, or unfortunately, a very large proportion of the public has obtained the impression that the London Electric is the sole company supplying a large area of the metropolis, and every *canard* about the electric light is laid to the London Electric. If a light goes out, or if a street is up, murmurs resound against this company. It has been our special object at various times to trace the correctness of these rumours, and having recently heard of stoppages, resolved to get at the truth of the matter. Enquiry at the fountain head results in our being able to state authoritatively that the number of stoppages has been three—one of four minutes, one lasting two minutes, and one lasting ten seconds. It is unnecessary to expatiate at length upon the mountain made in some quarters out of this molehill, which is not more than has happened to competitors during the same time.

To come to more important matters, the company is now supplying current for 37,243 lamps. This total is rapidly being added to, and in a short time—in fact, as soon as they can be connected—will reach 40,000 lamps. The machinery at Deptford is now capable, without addition, of supplying 90,000 lamps. The current is now regularly supplied during 22 hours a day, and from November 1st the supply will be continuous. For the moment the most important fact about the London Electric is that they actually and without difficulty supply current from Deptford generated at a pressure of 10,000 volts, a pressure unheard of in any other similar installation. Whether the system of generating at a distance, transmitting at a high pressure, and distributing by means of transformers, will be commercially successful is the question now under trial. The electrical engineer has solved one part of the problem—he can do his part of the work. It cannot be expected that a station laid out for, say, a quarter of million of lamps, will become a paying concern within a few months of its commencing operations. The company will now push ahead and strain every nerve to get the 90,000 lamps on; then it will consider exactly what it will do as regards continuing operations on the exact lines now laid down, or whether experience will dictate some modification. At any rate we ask electrical engineers to be less ready and less eager to believe everything that is said about any of the central station operations. There is one infallible test, only supplied by time in a series of annual balance-sheets. Wait for these before crying "spilt milk."

WHAT IS ELECTRICITY?

Most writers answer this question by candidly admitting their ignorance. Not so, however, a writer in *Science Siftings*—a new paper that is to educate the multitude. We have been violently assaulted—metaphorically—by unbelievers because of our cocksuredness upon certain questions, but we must bow before the new prophet. Some of our readers, in New Zealand or Australia, or some other benighted corner of the earth's surface, may not have the advantage of seeing the first number of this new paper, and we are thus enabled to enlighten them upon so important a topic. Well, but what is electricity? That is the question. Our contemporary promptly proceeds to riddle out three kinds for us. The result obtained is consoling, and accounts for many vagaries of expression with writers and speakers. In future, when attacked on account of ignorance, it is easy to reply, Oh! you are talking about one kind of electricity, I am talking about another. What are these three kinds of electricity? "First is the lightning which Nature produces. Then there is battery, *or static*, electricity (the italics are ours), which is generated by dissolving chemicals in cells, or batteries. The third sort is dynamic, being generated by a dynamo." A little further on, we are informed that static electricity is used in telegraphing and telephoning, and that there are *three* (italics ours again) kinds of dynamic electricity—continuous, fluctuating, and alternating. It may be reasonably agreed that hitherto the author has not answered his question, What is electricity? Neither does he, so far as we can find in the two columns he writes on the question. But he may be forgiven this lapse because of the amusing information he does give: "A powerful current is necessary to produce the arc light. It is produced by large dynamos furnishing great quantities of electricity, which is driven out under an immense pressure." Hitherto it has been generally recognised that the current in arc lighting is comparatively small, although the pressure may be large. So now we have the delightful fact that there are three kinds of electricity, but what either of the kinds electricity is we do not know. The main idea of this new comical scientific *Tit-Bits* contemporary is to get a circulation by means of coupons and prizes. If its prizes are as valuable as its information, the scientific world ought to create a new society and give the place of honour to this new departure. We badly want a good scientific dictionary, with crisp, clear, readable definitions, and for such work our contemporary is eminently fitted. To transpose his sentences: "This is induction. When a wire charged with a heavy current of electricity is strung parallel for a considerable distance to another wire upon which there is no electric current, or a much weaker current, the strongly-charged wire excites in the weaker wire a sympathetic current, which moves in the opposite direction, but vibrates, pulsates, crepitates, and in all other respects reproduces the manifestations of the current in the stronger wire."

Leaving electrical matters on one side, it is amusing to find that the subsequent rainfall after battles—does it happen except as a coincidence?—is caused by the excessive perspiration of the contending soldiers. Query: What amount of rainfall would be caused by compelling Prof. Huxley to be examined on page 5 of *Science Siftings*?

ANOTHER UNDERGROUND ELECTRIC RAILWAY.

The following paragraph appeared in the *Times* of Wednesday:

> "It is rumoured that the London and South-Western Railway Company intend to apply next session for powers to construct an electrical railway in a subway from Waterloo to the City. We have not been able to confirm the above; but the impression is that such a line would pay."

Without going into the pros and cons. as to whether it would pay, there can be no doubt that such a line would supply a want. At present passengers by the South-Western, season ticket-holders and others, are stranded on the wrong side of the Thames, and at a considerable distance from the City. They have the option of (1) crossing Charing Cross railway bridge and taking the Metropolitan; or (2) passing through Waterloo, South-Western, to the adjoining Waterloo Bridge, South-Eastern Station; or (3) taking 'bus or cab. None of these methods of reaching the City are wholly satisfactory, either from the point of view of the season-ticket holder without luggage, or the casual passenger with impedimenta, and for reasons which many of our readers can probably supply from their own experience. The proposed subway, if reached direct from Waterloo Station, would be very convenient. An important question of course is, Which route would be the best? If the subway merely followed the south bank of the Thames to London Bridge, the cost of crossing the river would be avoided, but the utility of the line would be impaired so far as persons desirous of reaching the districts about the Strand, Fleet-street, Ludgate-hill, and Cheapside were concerned. Moreover, if it was decided to keep to the right bank of the river, it might be easier and cheaper to run a branch line from the City and South London to Waterloo. The boldest, and, perhaps, the most useful project, would be to cross the river between Waterloo and Blackfriars Bridges, dive under the Metropolitan line, and make for Cheapside, where a junction might be effected with the future Central London line. This, if accomplished, might prove the feeler of yet another circular underground railway system for London, and one free from the abominable atmosphere of the present steam line. Or, and when we are dealing in futures it is easy to suggest, why not do away with steam on the Metropolitan, substitute electricity, and then run a branch across the Thames to Waterloo—the South-Western acquiescing? Whether the rumour given by the *Times* is true or not in fact, there can be no doubt that some such line as is alluded to is really wanted. There can also be very little doubt that it must be an underground subway, on which electrical energy is used for the purposes of traction. The question of questions is, What will it cost? And this will depend to a great extent on the answer to another question, Which route, other things being equal, will bring in the biggest receipts? At the present time electric traction on underground lines can hardly be called a financial success. Pioneer undertakings of this sort, like the City and South London, seldom are, however. When we get a complete electric traction system beneath London—and judging from the above ground traffic as well as that on the Metropolitan, there is room for it—the financial aspects may assume a brighter look. True, the Metropolitan Railway does not give an extravagant return to its shareholders, but there are reasons why electric traction on as large a scale should prove considerably cheaper to work with than steam, and consequently afford a better return on the capital invested.

LITERATURE.

A Practical Guide to the Testing of Insulated Wires and Cables. By Herbert Laws Webb. D. van Nostrand, New York; E. and F. N. Spon, London.

Electrical engineers connected with what may be termed the heavy part of the trade are on the high road to as carefully test every part of their apparatus, whether connected up or disconnected, as do cable folk. Mr. Webb in his little book, which, it may be stated, is a reprint of articles which originally appeared in the *Electrical Engineer* of New York, has made a successful first attempt to provide information as to testing for young engineers. We know how important are the considerations of space, and how desirous every author is of giving a little more information, but we are becoming very much of the opinion that the great fault of most books is telling too much. Our idea of a book on testing is to have it set out like some authors set out propositions in Euclid. Never mind that the page looks bare, so long as each step is shown and the result obtained is learnt. However, this is a mere matter of detail as to how the information should be given. As regards the information in Mr. Webb's book, he deals, as he says, with elementary testing, and we should imagine the reader to be very obtuse who could not understand everything written therein. The narrative is simple and to the point, the diagrammatic illustrations just such as are wanted to elucidate the text, and altogether it forms a good stepping-stone to Kempe's grand book. From the standpoint of heavy engineering, the reader must not expect too much, as the author does not touch upon magnetic work, or any of the great problems underlying distribution, he merely deals with the elementary tests of a cable, such as conductor resistance, insulation resistance, and capacity. These tests are, of course, the fundamental tests, and therefore we say this book is an excellent one for beginners.

THE LEEDS ELECTRIC TRAMWAY.

(Telegram from our Special Correspondent.)

Leeds, *Thursday afternoon.*

The electric tramway to Roundhay Park was successfully opened to-day in fine weather. The generating station is situated near Beckett-street, and there are about two miles of double and nearly as much of single track. The wires carrying the current are run overhead in the following manner: Iron posts are fixed on both sides of the street, those on one side carrying the feeders; a spanning wire is stretched across from post to post, and from the centre of this is suspended the trolley wire. The spanning wire is insulated at the posts, and the trolley wire at the point of suspension from the spanning wire. Two gauges of wire are used for the feeders—viz., 0000 B.W.G. and 00 B.W.G. The gauge of the trolley wire is 0 B.W.G. The spanning wire is of steel, No. 5 B.W.G., and has a tensile strength of 60 tons per square inch. At the depôt there are six cars. The generating machinery consists of two Thomson-Houston dynamos, each giving 300 volts at 900 revolutions. The driving engine is by McIntosh and Co., of Auburn, and has an 18in. cylinder with a stroke of 18½in. It is capable of working up to 200 h.p. with steam at 100lb. pressure, and runs at 200 revolutions per minute.

The opening ceremony naturally caused much interest in the town, and was attended by members of the Corporation and many others anxious to learn something of the details of overhead electric traction. Mr. Graff Baker is to be congratulated on his enterprise in carrying through this work, which will doubtless lead to a modification of the present distrust of the overhead system in England. I shall hope to give your readers a more detailed description of the line in a future issue.

CONSIDERATIONS GOVERNING THE CHOICE OF A DYNAMO.*

BY PROF. E. P. ROBERTS.

To select a dynamo for a given purpose is quite a different affair from designing one. In the latter case the type of machine is first determined and the proportions of the electrical details decided by deduction from theory and experiment. The proportioning of the mechanical parts must be kept in view while designing the electrical features, and both mechanical and electrical elements varied until they unite to best subserve the attainment of the object desired, which is the construction of a dynamo to do the work required with the minimum of first cost and with reliability and economy of operation. A dynamo designer should have, in addition to a knowledge of the laws governing electrical and magnetic circuits, a knowledge of machine design and construction. The knowledge so possessed must be applied to the study of the results following the modification of any feature in the general type and special form chosen. The study of the various losses taking place in a dynamo necessitates an analysis of the same, in order to obtain the value of each loss when the details of the general design are modified. Such losses are friction, ohmic resistance, self-induction, magnetic resistance, magnetic leakage, Foucault currents, hysteresis, etc. After obtaining the above information the dynamo designer will apply his personality—which is partly genius, but mostly the result of varied experience carefully digested—and the result will be a piece of apparatus which will accomplish the object desired with as much certainty as will a special machine tool designed by an expert in that line.

The purchaser of a dynamo approaches the subject from a very different direction. He desires a dynamo which is, above all, reliable; secondly, efficient as regards the ratio of the power generated to that consumed; and, thirdly, efficient in all the many ways which go to make any machine efficient in everyday use; fourthly (or firstly, secondly, or thirdly according to circumstances, but more generally according to the wisdom of the purchaser), cheap. In order to criticise a dynamo it is advisable to analyse it and study each element. In order to do this systematically, the following chart is prepared and then a few remarks made under each heading. The chart refers only to points to be studied by a purchaser. If a dynamo has 90 per cent. commercial efficiency under a certain load, he does not care what disposition is made of the 10 per cent. lost, provided it is not detrimental to the lasting qualities of the dynamo. It is all the same to him if 2 per cent. be lost in Foucault currents and 3 per cent. in ohmic resistance and 5 per cent. in friction, as it would be if the figures were interchanged, provided lubrication and insulation do not suffer.

DYNAMO.	MECHANICAL DESIGN.	*Strength, Rigidity, Accessibility, Lubrication, Revolutions per Minute.*
	CONSTRUCTION.	*Material, Workmanship, Balance, Manufactured to Gauge, Insulation.*
	ELECTRICAL DESIGN.	*Commercial Efficiency, Operative Efficiency, Adaptability to Work Desired, Heating, Sparking.*

These points will be considered in the following order: (1) mechanical design, (2) electrical design, (3) construction.

The divisions can be advantageously subdivided, but the line of demarcation is not distinct, and remarks under one head will sometimes be repeated in part, or referred to, under other divisions.

(1) Considering the dynamo as a mechanism, there present themselves as to its design: (A) the frame, (B) the bearings, (C) the revolving portion.

(A) The frame should be rigid, should give ease of access to the commutator and brushes for adjustment and cleaning, and should allow repairs to be made with ease and celerity to such parts of the mechanism as are subjected to the greatest stresses, electrical or mechanical, or to constant wear. The frame should make the centre line of the revolving portion as low as practicable, and have a good spread of base.

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* Paper in the *Journal* of the Association of Engineering Societies.

(B) The bearings should be of ample size, easily replaced, and have positive lubrication. Also, arrangements for catching the oil after use should be provided. No oil should creep along the shaft, or be thrown off. Oil in any other place than the bearings is not only unsightly and liable to cause fires, but also collects dirt and copper dust from the commutator, causing electrical troubles. Upon the score of economy all oil should be caught and strained, and then either mixed with fresh oil and used in the dynamo, or used for shaft or other slow-speed bearings.

(C) The revolving portion should be firmly fastened to a rigid shaft, and should not depend merely upon set screws or other form of frictional fastening. The shaft should never bend; since if it does, even to a slight degree, increased friction at the bearings will result. Possibly, also, the revolving portion may hit the stationary parts, or the shaft may break after running a short time. The fewer the revolutions per minute the larger the pulley upon the dynamo, and this is important, particularly when the dynamo is driven from shafting, as large pulleys—especially large friction pulleys—are expensive, and necessitate considerable space within which to rotate.

2. *Electrical Design.*—The main point to be considered, under the head of electrical design, by the purchaser of a dynamo, is its "commercial efficiency," which is the ratio of the power given out to that absorbed. The power given out is expressed in watts, and that absorbed in foot-pounds or horse-power. Another kind of commercial efficiency must, however, be considered.

First, the commercial efficiency in its limited sense as above used. Next the output per pound expended, (*a*) in buying the dynamo, (*b*) in furnishing power, (*c*) in operating expenses of all kinds, and (*d*) in reliability. Combining these is obtained what is herein termed the "operative efficiency."

It is very evident that an unreliable dynamo is not practically efficient, however well it can be made to perform during testing.

It is, of course, desirable that the dynamo should have a large output per horse-power absorbed—that is, "commercial efficiency"—not only when at full load, but under any fraction of the same. It is also desirable that it should have a large output: Per pound of first cost; per pound of repairs; per pound of attendance while running; per pound of attendance to clean; per pound of total weight; per square foot of floor space; per cubic foot space (in some places, as on board ship).

The output per horse-power expended at the dynamo pulley to drive the same is a matter easily obtained, to a fair degree of accuracy, without expensive apparatus.

The horse-power absorbed can be measured by a number of devices. Numerous forms of transmission dynamometers are in use. The pulley which transmits power to the dynamo is loose on the shaft and is rotated through the medium of spiral springs, one end of which is fastened to the pulley and the other end to a disc keyed to the shaft. Mechanism is arranged which indicates by a pointer the tension on the spring at any moment. The revolutions per minute being known, the horse-power can be computed. A scale is attached, and the horse-power transmitted can be directly read. Some prefer to have the figure indicated not to the actual amount, but one the value of which can be found by reference to a private notebook. The apparatus is split throughout, so that it can be readily placed upon any shaft, and bushings can be inserted to fit the shaft.

The Brackett cradle is extensively used, and consists of a platform upon which the dynamo is placed, said platform being suspended by end frames carrying knife-edges resting upon hardened surfaces. The dynamo shaft is adjusted until its axis passes through the line of the knife-edges.

The dynamo is so balanced by weights carried on horizontal arms, or on the bed of the cradle, that the latter swings easily and freely on the knife-edges, and by means of weights vertically above or below the knife-edges the centre of gravity is adjusted until any desired degree of sensitiveness is obtained—viz., until any desired change on the counterpoise or the horizontal arm throws the cradle out of balance. The centre of gravity must not be raised above the line of support or the cradle will be in unstable equilibrium—*i.e.*, will be top-heavy and will remain tipped to either side. The belt must be off the pulley while adjusting the weight.

When the dynamo is driven the reaction of the armature upon the field tends to rotate the system, and balance is maintained by adjusting the position of the counterpoise on the horizontal arm or by the extension of a spring scale balance attached to it. The continued product of the weight of the counterpoise (or pull on the spring balance), its horizontal distance from the centre line and the revolutions per minute of the dynamo, equals the foot-pounds taken by the dynamo.

The number of revolutions per minute may be determined by any one of several devices. A common method is to use a watch and a speed indicator, the point of which is held against the centre of the shaft and the speed is determined by noting the number of revolutions indicated on the dial during a minute or any convenient fraction thereof. This method is rather troublesome unless two observers are available, one to attend to the indicator and the other to call time. A convenient instrument combines the indicator with a stop-watch in such a way that the rotating point operates the registering device only for a certain length of time, so that the revolutions per minute are indicated directly. Another class of instrument is the tachometer, which may either be operated by a belt or may be held against the end of the shaft. In the tachometer centrifugal force causes a pointer to move along a scale graduated to read revolutions per minute. The greatest source of inaccuracy in the use of any of these instruments is the liability to slip. This is minimised in the case of instruments operated by contact against the end of the shaft by having sharp edges on the point or giving it a soft rubber tip. A good method is to use a three-edged punch and punch the "centre" with the same. The marks thus made hold the point of the counter and do not injure the centre. In the use of the tachometer and belt care should be taken that the belt is tight, and that the pulley on the shaft is of the exact size required. When an indicator is not obtainable the speed may be determined approximately by counting the revolutions of engine or shaft, and multiplying by the ratio between the diameters of pulleys. The speed of the engine may be counted by letting one hand move by some reciprocating part or allowing some part—such as a set screw on the shaft or crankpin of the engine—to strike the hand at each revolution, while a watch is held in the free hand.

One make of engine, the Idle, has an indicator of horse-power being developed. It really shows the point of cut-off. The number of revolutions and initial pressure of steam being known, the horse-power is determined, and the scale calibrated accordingly. If the friction be deducted, the amount being obtained by friction cards, the horse-power transmitted to the dynamos is closely approximated.

ENERGY DEVELOPED BY THE DYNAMO.

The energy now to be considered is that delivered by the machine to the external circuit. The location and character of the electrical losses in the dynamo need not be taken into account by the station operator, with the exception of the consideration that energy lost in the dynamo is converted into heat, and in general the less heating the better will be the "operative" and "commercial" efficiency.

In order to determine the output of the dynamo, it is necessary to measure the difference of potential (P.D.) external circuit. This is usually accomplished by a voltmeter and an ammeter of the proper range to take the measurements desired. In whatever way the P.D. and C. are determined, their product gives the energy in watts and this divided by 746 gives electrical horse-power. Electrical horse-power is the same as the standard mechanical horse-power, which is the work done by 33,000lb. falling 1ft. per minute, or the equivalent of the same.

In order to determine whether the dynamo will do the character of work desired, it is operated at the speed given by the manufacturer (not at some other speed and calcula tions made therefrom), and the C. and P. D. at the terminals measured, the energy developed being absorbed by any form of R convenient. A curve showing the C. and generator P. D. at various loads is constructed from data so obtained. If desirable curves are made showing the output at various speeds. These curves are called "*characteristics*," and bear much the same relation to a dynamo that an indicator diagram does to a steam engine.

In some cases it is well to prove the dynamo by "short-circuiting" it, and sometimes by suddenly "open-circuiting" it. Also to test the effect of slight variations in the position of the brushes.

From a financial standpoint the output per pound expended is evidently of importance, and under the same head can generally be placed, though to a lesser degree, the output per square foot of floor space occupied; and, where height must be considered, the output per cubic foot of space, and sometimes also per pound of weight. In most station work, however, the weight and height need not be considered as between dynamos of the same output. A large dynamo is cheaper and occupies less floor space per watt developed than its equivalent in smaller ones.

The allowance for repairs is generally figured as a certain percentage of the first cost, and is determined by experience. This is a very uncertain quantity, but where great care is taken to properly clean the dynamo, and keep the same in good condition (such as shellacing impaired insulation, etc.), and where open and short circuits do not occur on the line when operating, and the lightning arresters act properly, the repairs upon dynamos are usually very small, possibly not 2 per cent. per annum of the cost. In other cases it may reach any imaginable figure.

The output per pound of attendance to clean is, more or less, the reciprocal of the above. The more cleaning, the less repairs. Some dynamos, however, take much longer to clean than others, and some can never be thoroughly cleaned. The cleaning of dynamos is quite an expense in a large station, and an even larger percentage of cost in a small one, as a comparatively expensive man may have to do it at times when otherwise he might be more productively engaged.

The output per pound of attendance while running varies greatly. With some dynamos and their auxiliary mechanisms so much attendance is necessary as to be a considerable item in a small station, taking all of one man's time in a medium-sized station, and the time of more than one man if a large number of dynamos are running. This emphasises the fact, which no one not an operating manager and superintendent of a station fully realises, that in choosing a system there are many points to be considered besides commercial efficiency, first cost and electrical output of the character desired and as indicated by the characteristic curve.

The mechanical design should be such that the electrical functions of the different parts may not be destroyed by reason of insufficient rigidity, abrasion, etc. It is well to have the armature wires positively driven by the pressure of the parts of the armature frame. When an armature revolves rapidly, the wires, including the binding wires upon armatures using such, stretch and are liable to be more or less displaced unless firmly held. If shaft wires are used passing through the shaft to the collector, special care should be given to ensure a smooth and ample space for placing the same in position, and that dirt be not allowed to settle about the entrance and egress holes. The mechanical design of the commutator includes the matter of proper insulating material between each of the commutator strips and between them and the shaft, the whole being put together in such a way that no piece is liable to work loose.

The electrical design necessitates that there shall not be continuity of the iron of the armature core. The reason for this is that the same force which tends to produce current in the wire would produce current in the iron and heat it if the electrical circuit be complete. Such currents are called Foucault currents. Armature cores are therefore made of iron plates, bands, or wire; plates being used when the active wire is parallel to the shaft, bands when at right angles, and wire being applicable to either case.

(To be continued.)

THE TRENT GAS ENGINE.

Amongst the various gas engines which are coming to the front as motors for driving electric light machinery, the Trent gas engine is one which is worthy of some attention.

The engine stands on a solid cast-iron bed-plate. It has only one working cylinder and one piston, and the piston being carried at both ends is not liable to wear the cylinder, as is often the case with horizontal engines

The explosion is silent, and as the engine has no cogwheels, no rattling noise is experienced. This of itself is, of course, a great advantage when applied to running dynamos near houses or in a cellar. It is arranged to receive an impulse every revolution, and the running is very even and regular, and is therefore specially adaptable to driving dynamos. It has only a single crank, like that of a steam engine, cut out of solid forged steel, and has no complicated levers or links of any kind.

Amongst the other practical points of advantage, the Trent engine has no slide-valves, and no small parts or sensitive passages. The special point about the construction is the patent explosion-chamber. The explosion takes place outside the cylinder proper, and in the explosion-chamber itself there is no working part. The most intense heat is therefore outside the cylinder, and not on the piston, which therefore requires less lubrication and wears longer than can be the case with engines having the explosion direct. A great saving is also effected in the lubrication, as there is no burnt oil.

It is a slow-speed engine, working with a low-pressure explosive mixture. The initial pressure is only about 100lb. per square inch, against 200lb. or even 250lb. in other gas engines, so that the extreme difference is less, and the engine will "explode" with a gas mixture varying in strength to suit the power required. This, added to the fact of there being an explosion every revolution, makes the running very regular. Quite recently an engine was supplied for lighting the Drill Hall, Derby. During an exhibition of several weeks, although there was only one flywheel on the engine and none on the dynamo, and notwithstanding that there were no resistance coils or accumulators, the incandescent lamps were driven with perfect steadiness, the needle of the voltmeter showing no apparent variation.

As it compresses at a relatively low pressure, the engine is very easy to start, and owing to its special construction the starting is certain. This advantage is considerable in practice. The consumption of gas is exceptionally low, and is diminished by an efficient governor when the work is light. A recent test with indicator showed that a gross power of 10·2 i.h.p., and with the friction brake at the same number of revolutions (174), a useful horse-power of 6·4 e.h.p. This result was obtained with a consumption of 180 cubic feet of gas per hour, being less than 18 cubic feet per i.h.p. This result was with the earlier form, and the recent forms have tested even better than this.

The working parts consist only of the piston and steel valves, all easily accessible, not subject to undue wear, and all exhaust the exhaust valve, only needing the most occasional cleaning. The ignition, controlled by a small positive-acting valve, is absolutely reliable at any speed, and cannot take place prematurely. The exhaust gases escape at low pressure, and do not make any objectionable noise. The handling of the engine is easily learnt by any unskilled person.

The special patent governor motion cuts off the gas in event of the governor belt breaking, so preventing racing, or if the engine is accidentally stopped and the gas left in, danger from escape of gas is prevented. The very sensitive trip motion keeps the speed extremely even. The engines are made in sizes of 1½, 2½ (these being vertical), 4, 6, 9, 12, and 25 nominal horse-power. The 25-h.p. engine is a twin engine, having two impulses every revolution, specially adapted for electric lighting. The speeds range from 210 revolutions in the smaller sizes to 150 or 160 in the larger ones. The latter can, however, be run to 180 or 200 revolutions if desired, with proportionate increase of power. The brake horse-power is considerably more than the nominal horse-power. The Trent Gas Engine Company are also making 80-h.p. engines, having four impulses every revolution, especially for electric lighting purposes. They have just completed an engine for electric lighting giving 32 i.h.p. at 160 revolutions, using about 450 cubic feet of gas per hour, a result very satisfactory indeed.

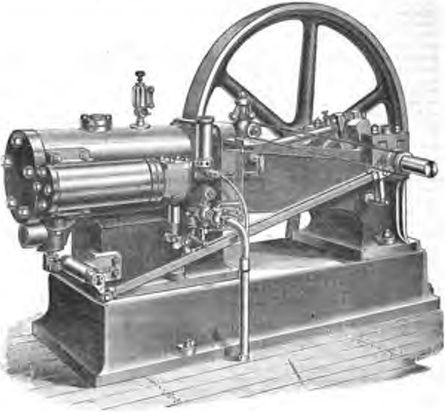


FIG. 1.—The Trent Gas Engine.

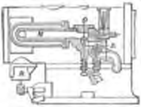


FIG. 2.—Explosion Chamber, in Section.

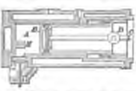


FIG. 3.—Vertical Section of Engine.

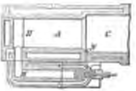


FIG. 4.—Horizontal Section.

The outward aspect of the gas engine is shown in Fig. 1, while the details of the construction are represented in Figs. 2, 3 and 4.

In the figures, A C is a cylinder of two diameters, in which works the double-headed piston, B D. When this piston makes its out-stroke, gas and air are drawn into the part C through a simple steel valve, E. On the return stroke of the piston, B D, this valve is closed mechanically,

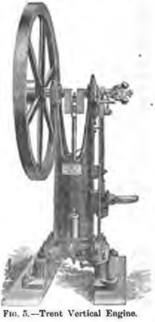


FIG. 5.—Trent Vertical Engine.

and the mixture of gas and air contained in C is forced through the valve, O, into the explosion-chamber, M, where it is compressed (driving before it the exhaust gases remaining from the previous explosion, which escape through the valve R), and the mixture is then ignited. The resulting expansion impels the piston outwards. The acquired momentum of the flywheel performs the in-stroke.

The Trent Gas Engine Company, whose address is New Basford, Nottingham, supply a complete small electric lighting installation—consisting of 1½-h.p. Trent gas engine with bed-plate (no other foundation needed), tank, anti-fluctuator, bag, and all piping, except from meter and to exhaust, together with compound-wound dynamo, belt, fuses, switches, and wires for one 150-c.p. Sunbeam lamp and 12 16-c.p. incandescent lamps, opal shades—the whole forming a neat and compact installation. One of these small installations is shown running at the Brewers' Exhibition at the Agricultural Hall.

WATT'S ELECTROLYTIC ZINC PROCESS.

The importance of a practical process for the extraction of zinc from its ores by electrolysis has always been fully recognised, and the desire to furnish such a process has been shown by the goodly list of patents which have from time to time been taken out in this and other countries for the treatment of zinc ores by the electrolytic method. It is now well known, however, that none of these processes have been successful when attempts have been made to carry them out, even on a moderate commercial scale. The causes of failure which have hitherto beset the path of the inventor have been many, but the chief difficulty has ever been in the nature and preparation of the electrolyte, and this, as is well known, is the most important factor in any electrolytic process which involves the deposition of a metal from its solution, but more especially so when such metallic solution has been obtained direct from the ore.

In dissolving out the oxide of zinc from calcined blendes, hydrochloric acid presents several advantages, but since chlorine is set free at the anode during the electrolysis of the zinc chloride formed by its agency, this acid may be considered unavailable for the purpose. Sulphuric acid has therefore been the accepted solvent of the zinc oxide, and the zinc sulphate has been repeatedly tried as an electrolyte for the extraction of metal from the ore. The objections to sulphate of zinc as an electrolyte are by this time pretty well known. However, it may be well to recall a few of them to show how unreliable is a solution of this salt for the reduction of the metal by electrolysis, but more especially so when insoluble anodes are employed, as in the extraction of zinc from solutions obtained from the ore: 1. As soon as the electrolyte becomes even moderately acid from the extraction of a portion of its zinc by deposition upon the cathodes, polarisation at once sets in, and the plates become covered with dark patches, the same appearance being usually manifest also at the upper surface of the plate. 2. The deposited metal, instead of assuming the true reguline character, having a perfectly metallic appearance, often occurs in the form of a non-reguline grey powder, which may readily be wiped off the plate with the finger. This granular metal, if allowed to deposit to any appreciable extent, frequently acquires a spongy form of considerable thickness, and of a dark grey colour, in which condition it is quite unsuitable for melting. 3. The zinc, soon after a very moderate thickness of the metal has been deposited upon the cathodes, commences to form in the shape of branching crystalline growths—especially at the corners and edges of the plates—and these so-called "trees" quickly spread out in the direction of the anodes until they finally come in contact with those electrodes, when, as a matter of course, the current is short-circuited, and the further deposition of the metal brought to a standstill. The inconvenience attending crystalline growths of this character cannot well be over-estimated, and it seems tolerably clear that if there were no remedy for such irregularities, that an electrolyte which favoured their formation would be practically useless for the commercial production of zinc by electrolysis.

Having, some years before, obtained some very satisfactory results from solutions of metallic salts prepared from the vegetable acids, it was resolved to ascertain if an electrolyte of practical utility could be formed by employing a vegetable acid as the solvent for oxide and carbonate of zinc, and for this purpose the cheapest of these, acetic acid, was at once selected for the first trial. The substance first operated upon was an impure form of oxide of zinc known as "flue-dust," which sometimes contains from 2 per cent. to 6 or 8 per cent. of oxide of lead, besides other metallic and earthy impurities. To dissolve out the zinc and lead from the impure oxide, ordinary commercial acetic acid (15 per cent. real acid) was employed, and to a quantity of this acid flue-dust was gradually added, a little at a time, and the mixture well stirred until the acid was neutralised. The whole was then allowed to stand for a few hours, when the clear liquor was run off into a separate vessel; scrap zinc was now thrown into the liquid for the purpose of precipitating the lead held in solution by the acid.

When the whole of the lead had been thrown out of the solution by the zinc, the undissolved portions of the latter metal were removed, and after a few hours' rest the clear liquor was run into the electrolytic tank, and the precipitated lead, after being well washed, was put aside for melting. The electro-deposition of the zinc was next proceeded with, carbon anodes being employed, and some very good results were obtained, the reduced metal being of very good quality. The E.M.F. required was, however, found to be rather high, and this induced the author to seek an improvement in the direction of diminishing the resistance of the solution. With a full knowledge of the defects inherent to the zinc sulphate solution as an electrolyte, as before explained, when employed *per se*, and having before obtained some very good results from mixed solutions of metallic salts prepared with mineral and vegetable acids respectively, it was determined to make a series of experiments with a view to improving the zinc sulphate solution so as to make it available as an electrolyte by removing, if possible, its characteristic defects—namely: (1) Its disposition to deposit the zinc in a granular or spongy form; (2) its invariable liability to yield crystalline deposits of a tree-like form. In pursuing these experiments, varying proportions of solutions of zinc acetate, citrate, or tartrate, etc., were added to neutral solutions of zinc sulphate, and the compound electrolytes were then tried with a suitable current for obtaining a prompt but not too rapid deposit of zinc, carbon anodes being employed as before. It may be said with truth that the first trials with the compound electrolytes were distinctly, and indeed remarkably, favourable. Instead of the metal assuming the grey, spongy, or granular condition, it was almost white, perfectly reguline, and possessed a fine metallic lustre, and in lieu of the fibrous crystalline deposit sometimes obtained in zinc sulphate solutions, the metal assumed a nodular or botryoidal form of a decidedly solid character, and absolutely free from "treeing."

Having advanced thus far in the direction of obtaining a suitable electrolyte for the deposition of zinc, it next became a question of selection, and from considerations of economy and practical usefulness, mixed solutions of acetate and sulphate of zinc were taken, about 10 per cent. of the acetate solution being added to about 90 per cent. of the sulphate solution, and the compound liquid was then reduced with varying proportions of water, the density being taken with the hydrometer after each addition, and the solution was electrolysed after each addition of water until the specific gravity of the liquid most suitable for the electrolyte was determined. Having now succeeded in obtaining a solution from which zinc could be deposited in the best possible condition for melting, it next became necessary to see how the compound solution would work when prepared on a larger and more practical scale. For this purpose, a quantity of impure oxide of zinc, containing at least 5 per cent. of lead, was first treated with 15 per cent. acetic acid for the purpose of dissolving out the lead oxide (a portion of zinc oxide, of course, dissolving also), and the resulting acetate solution was then allowed to settle, when the clear liquor was run off as before, and the lead precipitated with scrap zinc. When it was found that all the lead has been thrown down, the clear solution was then transferred to tanks furnished with carbon plates for anodes and plates of sheet zinc for the cathodes. The current was then switched on and the deposition of the zinc allowed to proceed for some hours, by the end of which time the plates had received a considerable thickness of zinc of a very good colour, and quite free from "treeing." During the electrolytic action there was no evolution of hydrogen at the cathodes, but a slight frothing at the anodes due to the liberation of oxygen at those electrodes. In the trials referred to the current was varied from time to time in order to determine the most economical conditions of working, and it was found that a current of 3·2 amperes per square foot of cathode surface, the E.M.F. per tank being 3·38 volts, gave the most favourable results. Thus: 30 tanks, having 312 square feet cathode surface in each = 9,360, would give a deposit of four tons 16cwt. per week of 144 hours. The theoretical deposit of zinc per ampere per hour being taken as 18·9, the result given was found to be equal to about 95 per cent. of the possible quantity, which, in the deposition of a metal such as zinc, with insoluble plates for the positive electrodes, may be considered a very good result. Moreover, the temperature of the solution at the time these trials were conducted was somewhat low for an electrolytic operation, being only 50deg. F. At a higher temperature, say about 70deg. F., far more economic results would undoubtedly be obtained, as will be well understood. Respecting the density of the solution, many comparative trials were made, and it was found that a specific gravity of about 1130 (water being 1000) yielded the most favourable results. It should also be mentioned that the carbon anode connections were very imperfect, which would naturally tend to increase the resistance of those electrodes, and necessitate a higher E.M.F. than would otherwise be required. To determine the distance at which the electrodes should be placed apart, several trials were made, when it was finally decided that about 2in. apart was a very good working distance, and they were therefore uniformly kept at that distance in all subsequent trials.

Since the foregoing results were obtained, a further series of tests was made, with a view to still further increase the efficiency of the process, when it was found that with a current of 4·2 amperes per square foot of cathode surface, and an E.M.F. of 3·0 volts, the exact theoretical quantity of zinc—18·9 grains per foot per ampere-hour—was deposited, showing (1) that a more suitable current density was used than in the former trials; (2) the temperature of the solution (60deg. F.) being 10deg. higher than when the former trials were conducted, the E.M.F. was sensibly reduced. Respecting the solution obtained from the ore, it was found, after throwing down the lead with scrap zinc—which zinc, by the way, is recovered with the zinc from the ore—that a small quantity of iron had been dissolved by the acids employed, but no trace of this metal, however, appeared to be deposited with the zinc; indeed, this would seem to be a chemical impossibility, for the iron, as soon as it is set free by the action of the current, is at once oxidised by the oxygen liberated at the anode, and deposits at the bottom of the tank as peroxide, and is therefore perfectly harmless so far as the electrolyte is concerned, and cannot deposit with the zinc upon the cathodes. It should be stated that when the deposited zinc was stripped from the plates, melted, and cast into ingots, these, when broken, exhibited a fine crystalline fracture equal to the best commercial spelter.

When treating blende, or sulphide of zinc, by this process the ore is first crushed, ground, and calcined; and in order that the oxide zinc and lead (if any of this metal be present) may be readily dissolved by the acid solvents, the calcined or roasted ore should be reduced to a fine powder. The dissolving of the oxides from the ore is then conducted as follows: A cylindrical wooden tank, having an agitating arrangement attached for the purpose of well mixing the powdered ore with the acid solvent is provided, and a quantity of 15 per cent. acetic acid is put into this tank, called the "dissolving tank." A calculated proportion of the powdered ore, according to its ascertained percentage of oxides zinc and lead, is now gradually introduced into the dissolving tank, its agitator being previously set in motion, until the entire quantity has been introduced, and agitation is kept up until the solution is neutral, or nearly so, to litmus paper, which generally occupies about an hour. The vessel is then allowed to rest for about 12 hours, when the clear liquor (acetate of zinc and lead) is run off; water is then pumped in, and the agitator again set in motion for a few minutes to enable the water to wash out a greater portion of the zinc salts from the residual matters. Agitation is now stopped, and the sediment allowed to deposit, when the clear liquor is again run off and added to the first liquor. Another washing or two may be given if necessary, and these weaker liquors may be used in lieu of water in subsequent operations. The liquors obtained from this first operation are then treated with scrap zinc to throw down any lead that may be present. A quantity of dilute sulphuric acid—about one part acid to six parts of water—is next run into the dissolving tank, the agitator set in motion, and the agitation kept up until the liquor has become neutral, or nearly so, a slight trace of free acid not being very objectionable. The agitator being stopped, the vessel is allowed to rest until the residual gangue has deposited, when the clear zinc sulphate solution is run off as before, and the residuum then washed, the first and second runnings being mixed together as in the first operation. The solution of zinc acetate (deprived of its lead as described) is then to be added to the zinc sulphate solution, and the compound liquid is then ready to be transferred to the tanks in which the metal is to be reduced by electrolysis. When mixing the zinc acetate and sulphate solutions, an hydrometer should be floated in the liquor, and the specific gravity noted from time to time, and, when necessary, the solution may be reduced by adding the requisite proportions of the wash-liquor from the dissolving tank. The solution should stand at specific gravity 1130 or thereabouts.

The compound solution of acetate and sulphate of zinc is put into tanks furnished with plates of carbon, arranged at about 4in. or 4½in. apart, each plate having a strip of sheet lead lapped firmly over its upper end, so as to form a good connection between the carbons and the supporting rods. The cathodes may consist of thin plates of Silesian sheet zinc, on which are left two or more equidistant projections, which, being bent in the form of hooks, are used to suspend the plates from the conducting rods to which they are to be connected. The electrodes, as also the baths, are connected in series. In order that the solution, when the current is passing, may be kept in as uniform a condition as possible, a system of circulation must be adopted, by which the partially-exhausted liquor of the electrolytic tanks is allowed constantly to flow out of the tanks into a receiving vessel, and an equivalent quantity of fresh liquor is as constantly supplied to the tanks from a head tank fixed at one end of the series. The partially-exhausted liquors, having now free acid in place of the zinc removed from the solution by deposition upon the cathodes, is recuperated, and its free acid neutralised, by being agitated in a tank or vat furnished with a proper agitator, in which is placed a sufficient quantity of powdered ore (previously deprived of its lead, as described, if any be present) and the agitation is maintained until the liquid again becomes as nearly neutral as possible. The liquor, thus restored to its proper condition, is then allowed to settle until quite clear, when it is removed to a store vat, from which the head tank is supplied with zinc liquor for the electrolytic tanks. This system being kept up with perfect regularity in all points, the operation proceeds with uniform results.

(To be continued.)

THE WIGAN TRAMWAYS.

We are under the impression that while such estimates as the following possess a certain value, they do not contain the estimates that form the crux of the whole question. The extra initial expense of £5,000 or £10,000 is often not worth five minutes' consideration, providing the working expenses and cost of maintenance are satisfactory. Let us take an example. Suppose a tramline on one system costs £20,000 and on another cost £30,000, and let the earnings be the same whichever system is installed—say, £5,000 a year.

Now suppose the working expenses and the cost of maintenance of the cheapest system to be 75 per cent. of the receipts, and in the other case 50 per cent. The balance for dividend in the former case is £1,250, in the latter £2,500—that is, the one pays $6\frac{1}{4}$ per cent., the other $8\frac{1}{3}$ per cent. The initial expenses, then, although very important, even when known leave some other knowledge to be desired. Contractors are perhaps not the best people to supply this information, but surely if Wigan is definitely thinking of electricity some information can be had from Blackpool in this important branch of the case, and a suitable allowance made if the system suggested is different from that in actual operation. The following is the information to which we have referred:

Sun Bridge-chambers, Bradford, October 17th, 1891. Mr. John Gee, Wigan. Dear Sir,—I have gone into the cost of electricity, and beg to send you some figures for your perusal. They are necessarily rough, but sufficiently accurate for discussion of the question. Electricity will cost more on capital account than steam; but it is for you, the Corporation, and the road authorities to seriously consider the matter of adopting a system which will rid the streets of the engines, and considering the weight of engines (10 tons) the life of the rails will be much longer, and the cost of repairs to pavements will also be considerably reduced thereby. In the event of the Corporation and road authorities deciding, upon some amicable terms, to take over the roads as per Mr. Alderman Ackerley's speech in the Council on 7th inst., a most proper thing for them to do, it is possible they would also elect to do all the work on the roads, such cost to be capitalised and interest paid by you for the outlay, you, however, to be at the cost of keeping the installation in good working order. The cost to you of the power, dynamo, and necessary work at the depots for the generation of the electricity and the equipment of the road with cars will be far greater than if the road is re-equipped with steam engines and cars. But I wish you to consider the great opportunity there is in Wigan of adopting a system so noiseless and healthful as compared with steam, and one which has now passed beyond the region of experiment. There are in America (apart from several on the Continent) 140 roads in use on the system I recommend for your adoption. I have visited some of the roads both in America and on the Continent. The first road in England on the system recommended will be opened at Leeds this month, and yesterday I went over to Leeds and saw the chairman of the Tramway Committee of the Leeds Corporation, Mr. Alderman Firth, and the engineer of the line, Mr. Winslow, and arranged that you should the first week in the next month, on some convenient day, invite the members of Mr. Alderman Ackerley's committee and the members of the various committees appointed by the Local Boards of Pemberton, Ince, and Hindley to see the road in working order for themselves. This, I take it, will be desirable on all points, as it is impossible for them to discuss the merits of my proposition without seeing the system in active operation.—I am, dear Sir, yours obediently, John Waugh. P.S.—As I am not known to any members of your Corporation or local authorities, I have ventured to ask our town clerk, who has known me 20 years, to introduce me to your town clerk, and I send you a copy of such introduction as follows: "[copy.] Town Clerk's Office, Town Hall, Bradford, 16th October, 1891. My Dear Sir,—I understand that Mr. John Waugh, C.E., of this borough, is in communication with your Town Council and yourself on the subject of tramways at Wigan, and as you will naturally wish to know what Mr. Waugh's experience may be in such matters, I have great pleasure in assuring you that he is thoroughly master of the whole business, whether the tramways be worked by animal power or by steam or electricity, as well as haulage by underground cable. As the engineer for a company here, to whom the Corporation leased an important and very difficult line of tramway on severe gradients, he gave the highest satisfaction both to the Corporation and to the company. Whenever I want a bit of sound, friendly advice, I apply to him and get what is wanted. Only recently I consulted him about a contemplated electricity line, and I know that at St. Helens he converted the tramway undertaking from a dead loss into a successful business. I write this with full knowledge of the responsibility you bear towards your Corporation, and am justified in assuring you that you may safely rely on any advice or assistance you may require from him.—Kind regards, yours truly, W. T. McGowen. Arthur Smith, Esq., town clerk, Wigan." Rough estimate for electrical trams—total cost: Engine at Pemberton Depôt, 200 i.h.p. maximum, £800; two boilers, £850; chimney, £250; dynamos, straps, etc., £2,000; six miles of posts at 100 posts to the mile, 50 on each side at £6 each, £3,600 (see note as to wood posts); 600 posts fixing at £1 each, £600; 12 miles of wire, 1,800lb. to the mile, at 8d. per lb., £720 (one wire overhead and one between the lines under pavement); fixing wire overhead and between rails, £550 (see note *re* wire between rails); wires and suspenders, insulators, and turnouts, £375; 10 cars, with motors, at £950 each, fitted with electric light, £9,500; four spare cars without motors, £250 each, £1,000; 10 per cent. for contingencies, £2,024—total £22,269. Estimated cost to Mr. John Gee, provided he find the power, dynamos, etc., in sheds, and for road equipment, rolling-stock, etc.: Stationary engine at Pemberton Depôt, 200 i.h.p. maximum, £800; two boilers and chimney at Pemberton Depôt, £1,100 (one boiler will be sufficient for power required); dynamo, straps, etc., £2,000; 10 cars, with motors, at £950 each, fitted with electric light, £9,500; four spare cars, without motors, £250 each, £1,000; 10 per cent. for contingencies, £1,415—total £15,815. Note.—As to cars on the electrical system, there would be no upper saloon. On the question of stability, I am of opinion that the cars with such upper saloons, on a four-wheel base and a 3ft. 6in. gauge, have not a sufficient margin in the interests of public safety. Estimate of costs in roads, provided local authorities find capital for all in the streets: Six miles of posts at 100 posts to the mile, 50 on each side at £6 each, £3,600 (see note as to wood posts); 600 posts at £1 each, £600; 12 miles of wire, 1,800lb. to the mile at 8d. per lb., £720 (one wire overhead and one between the lines under pavement); fixing wire overhead and between rails, £550 (see note *re* wire between rails); cross wires and suspenders, insulators, and turnouts, £375; total, £5,645; 10 per cent. for contingencies, £584; total, £6,429. Notes.—Length of road: A little over five miles only, so that the estimate is in this regard in excess of requirements. Wood posts: 10s. to 15s. each, only making a great difference in cost. Wire between rails: If this was done on the relaying of the track, the cost would be very much reduced. Steam engines, etc.—Equipment of road: Twelve engines at £800 each, £9,600; 12 cars at £280 each, £3,360; 10 per cent. for contingencies, £1,296; total, £14,256. Summary and comparison: Electrical installation and equipment, £22,269; steam engines and cars, £14,256; difference (capital) £8,013 (5 per cent. on = £400 per annum). This will be more than compensated for in the difference of cost of working between steam and electricity. Less cost of fuel, wear and tear, shop wages, drivers, and conductors. N.B.—Provided electricity is adopted the cost of putting the rails into order will be considerably less than in steam, as apart from the nuisance of the engines, they weigh 10 tons, and our weight would not exceed four tons, a great difference in the matter of life of rails, and wear and tear of same, and repairs to pavement.

OPENING OF THE DUSSELDORF CENTRAL STATION.

On the 1st September, Messrs. Schuckert and Co., of Nuremberg (who are represented in England by Mr. Charles Müller, of Bradford), completed the municipal electricity works in Dusseldorf, which they had carried out on behalf of the Town Council. Since that day the works have been in regular operation, but it was only on Saturday afternoon last (24th) that the inauguration took place. The Düsseldorf municipality now own the gas, water, and electricity works, which are under the management of Herr Grohmann.

As at present arranged there are one principal and three secondary stations, the central one being very close to the gas works. This method has been adopted so as to combine the two undertakings under one general management, and also to allow of a plentiful supply of coal to be at hand. The sub-stations are situated at a distance of about one and a half miles from the central station, the first being in Bleichstrasse, the second in the Bade-Anstalt, and the third in Karlsstrasse. The current from the generating dynamos is used partly to charge the secondary batteries in the sub-stations, and partly to feed the distributing mains simultaneously with the accumulators. The latter receive the current which is in excess of temporary demand when the machines are running at normal load, and in the hours of minimum demand they alone suffice, whilst when the consumption of current is the greatest, both the batteries and the dynamos work in conjunction. By this means it is claimed that the dynamos run at regular load during all working hours.

The central station contains three water-tube boilers made by the Hohenzollern Company, of Düsseldorf, one being as reserve; each has a heating surface of 150 square metres. The two steam engines, which will shortly be supplemented by a third, were supplied by the Saxon Engineering Works, of Chemnitz; they are of the horizontal type with tandem cylinders, work at 120lb., and are of 300 normal horse-power. Each engine is direct coupled to a Schuckert dynamo giving 1,000 amperes at 350 volts. In addition to the mains connecting the central with the sub-stations, and which were furnished by Messrs. Felten and Guilleaume, of Mulheim-on-the-Rhine, communication is possible by means of signals and telegraph wires. Two of the sub-stations contain small batteries, whilst in the third, near the Tonhalle, two sets of 140 cells, each placed in parallel, and having a total output of 1,000 amperes, are arranged. These storage batteries were provided by the Accumulator Works Company, Limited, of Hagen, who have undertaken to maintain them for 10 years. A constant voltage of the current at the places of consumption is effected by the regulation of the batteries at the secondary stations.

The generating station has been equipped for the simultaneous supply of 10,000 incandescent lamps, and the distributing mains to carry current for 25,000 lamps. Ample space is available for the erection of both generating and storage plant. Applications equivalent to 15,000 16-c.p. lamps have already been received, and 171 installations, comprising 12,000 lamps, are either already put up or in process of installation.

THE GOVERNMENT AND THE TELEPHONES.

A correspondent writes the following letter in the *Times* of Friday:

Since my return to London I have read the correspondence that took place a few weeks ago in the *Times*, and the comments of the electrical journals on the proposed new departure as to telephones.

I am not a shareholder in and have no direct or indirect financial interest in any telephone company, but I have used the telephone for several years, and, in common with all who use it, I am interested in the discussion which took place in your columns during the vacation. The service in London is not perfect, yet it is most useful, and has been much improved since the amalgamation of the companies, and doubtless every improvement that can be made, under existing conditions, will be effected by the able men who direct the National Telephone Company.

Mr. Bennett's wish is to establish an ideal telephone service at very low rates of subscription, and naturally we all wish to have such a service. Many practical men say, and the electrical papers seem to agree, that Mr. Bennett's plan, so far as he has made it known, cannot be made commercially successful. It is certainly strange that the National Telephone Company should have allowed Mr. Bennett to leave their employment, if they believed he could render their service many times more efficient than it now is, while reducing the cost to subscribers, and at the same time enabling the company to earn larger dividends than they are now doing.

I have no wish to enter into the merits of the existing system as compared with that suggested by Mr. Bennett and others; for it seems to me that a very important public question is involved in this matter of telephones—one which concerns the good faith of the Government.

Shortly after the telephone company started, the Post Office brought an action against that company, claiming a monopoly of telephonic, as well as of telegraphic, communication. It is well known that the decision of the court of first instance was in favour of the Government; but it was felt at the time, and is felt by lawyers and others still, that if the company had appealed the decision of the court of first instance would almost certainly have been upset. The Post Office, however, offered the telephone company a license for 30 years, on their paying a royalty of 10 per cent.; the company not having much money, and shrinking from a costly legal fight against the Government, accepted those terms; and on the strength of this long license, far more than on their patents, a capital of more than two and a half millions of pounds has actually been paid by the shareholders and expended in the development of the system from the crude state in which it was when they commenced business.

It seems now that the National Telephone Company is threatened with the active opposition of other companies licensed by the Post Office, and even by the Post Office itself. There is to be free trade in telephones in England, in face of the partnership in profits which exists between the Post Office and the National Telephone Company.

As the telephone company has not taken any part in the correspondence in the *Times*, I presume we are right in thinking that they are not seriously afraid of this competition. Perhaps they are right, inasmuch as at enormous expense they have got trunk lines all over England and Scotland, and it does not seem probable that any other company will be able to get trunk lines throughout the kingdom at much less cost than has already been paid by the National Telephone Company, and that therefore it is hardly probable that there will be any second trunk line through the kingdom. If the Government establish or favour another trunk system it can hardly be expected to pay.

But, Sir, cannot we take, and ought we not to take, this discussion as to the future of the telephone in England out of the domain of rival companies, and ought we not to look fairly in the face the question of the Government buying up the existing telephone companies, or, if they refuse to buy, then standing aside and allowing their responsible licensee to carry out the business for which they licensed the company, on the good faith of which compromise the very large capital has been raised and spent!

Mr. Preece, the Post Office adviser in such matters, said, in his address before the International Electrical Congress at Frankfort in September last: "In a commercial country like England an invention to attract attention and to prosper must be patented. It must have the prospect of great gains to attract capital. It must therefore be developed by private enterprise. When a new industry has thus been developed, and when it affects the public weal, Government is forced to step in and take the control of it." I have never seen the license which the Government granted; it is, however, common knowledge that the Government reserve to itself the right to purchase the telephone companies at certain periods, one of which expired on June 30 last. Ought not the Government to have exercised this right in June last? I judge from what Mr. Preece said at Frankfort that the Post Office, wisely realising the importance of acquiring the telephones, and knowing they would never again buy them up so cheaply, were in favour of exercising their right of purchasing on June 30 last, but, as the purchase was not made, I suppose this wise policy was overruled by the Treasury. I presume that, the period having elapsed, the Government have lost their absolute right to purchase the telephones in the present year. Surely, however, it will be better that they should approach the telephone company, and arrange to purchase all their interests under the conditions of the license, rather than that we should have an unseemly quarrel, and a number of rival companies starting, very few, if any of them, ever paying a dividend. Moreover, is it right that a Government department, having granted a license under which they benefit largely, and in consequence of which two and a half million sovereigns have been raised, should throw obstacles in the way of or even trade against their licenses?

We all want a perfect telephonic system. The Government could establish such a system better than anyone else, and, best of all, the telephone department of the Post Office would pay well, for the National Telephone Company is paying well. The rental for the year ending April 30, 1890, was given in the *Electrician* as £364,704. 17s. 5d., and for the year ending April 30, 1891, at £422,378. 6s. 2d.; the balance to the credit of net revenue this year is given as £194,821. 8s. 1d.

The Government could do, at any rate, as well, perhaps better, as they can raise the necessary stock at a cheaper rate than any company. If the Government do not buy now, it will cost them very much more to acquire all the telephone companies at some future date, and this will be a great mistake. I do not know whether the telephone company wishes to sell; I feel sure that it will be for the public advantage that the Government should purchase.

THE ELECTRO-HARMONIC SOCIETY.

A smoking concert will be held on Friday, November 6, at the St. James's Hall Restaurant (Banquet-room), Regent-street, W., at eight o'clock. Artistes: Masters A. Dearden, F. Cooper, S. Newton, A. Wells, and F. Dalton; Mr. H. W. Nicholl and Mr. Alfred Moore; humorous songs, Mr. Herbert Schartau; solo flute, Mr. John Radcliff; pianoforte solo, Mr. Alfred E. Izard; musical directors, Mr. T. E. Gatehouse and Mr. Alfred E. Izard. A Broadwood piano will be used. The following is the programme:

PART 1.

Part Song ……………"As it fell upon a day."……………….Bishop.
Masters A. Dearden, F. Cooper, S. Newton, A. Wells, and F. Dalton.
Song…………………"Lucia."……………………L. Luzzi.
Mr. W. Nicholl.
Pianoforte solo …… …"Etude L'Automne."……………Chaminade.
Mr. Alfred E. Izard.
Aria………… …"Within this Hallowed Dwelling." …….. Mozart.
Mr. Alfred Moore.
Canon ……………………"Go pretty rose." ………………Marzials.
Masters A. Dearden, F. Cooper, S. Newton, A. Wells, and F. Dalton.
Flute solo………… ……"Scotch Fantasia." ……………Richardson.
Mr. John Radcliff.
Humorous song………………………………………
Mr. H. Schartau.

PART II.

Duet…………………… "The Moon has Raised"… ..Sir J. Benedict.
("Lily of Killarney.")
Messrs. W. Nicholl and A. Moore.
Song…………………"The Lark now Leaves"……………Hatton.
Master F. Dalton.
Flute solo …… …………"Irish Fantasia" ………… ………Saunby.
Mr. John Radcliff.
Song……………… ……"Castles in the Air"……………Ballantyne.
Mr. W. Nicholl.
Part Song………… "Twelve by the Clock"…………E. H. Lloyd.
Masters A. Dearden, F. Cooper, S. Newton, A. Wells, and F. Dalton.
Song…………………"I Never can Forget"……… ……Mellon.
Mr. Alfred Moore.
Humorous Song.. ………………………………… ….
Mr. H. Schartau.

THE ELECTRIC LIGHT AT KIMBERLEY.

A new electric lighting installation has just been completed at Kimberley, and is giving great satisfaction to the townspeople. About two years ago Mr. D. A. Bremner, formerly of the Brush Company, was appointed borough electrician, and on entering on his duties he found the plant in use to be so unsatisfactory that he recommended that it should be replaced throughout. This recommendation was approved of, and the completion of the work has just been celebrated with some little ceremony. The Mayor presided on the occasion, and in the course of his speech said "a tribute of praise was due to their energetic borough electrician, Mr. Bremner, to whose efforts they owed the possession of what was certainly the first electric lighting plant in the colony." The engine was then christened by the Mayor, and the machinery was then started by Mr. Bremner. In the course of a luncheon held afterwards, Sir J. D. Barry, president of the Education Commission, congratulated Kimberley on having "such a magnificent lighting plant." At a meeting of the Borough Council subsequently, a special vote of thanks was passed and entered in the minutes, expressing "the satisfaction of the Council with the masterly way in which Mr. Bremner had brought the new machinery to a completion." The installation consists of 56 arc lamps, with an aggregate illuminating power of 100,000 candles, and the cost of the renewal has been about £6,000.

COMPANIES' MEETINGS.

BABCOCK AND WILCOX, LIMITED.

The first general meeting of this Company was held on Tuesday at the Cannon-street Hotel, Mr. Andrew Stewart, the chairman, presiding.

The **Chairman** said the meeting was merely statutory. The allotment of the shares, which took place on July 7, was of a very satisfactory kind, and the applicants were composed of the agents and officials and servants of the old company, who were supposed to know something of the merits of this patent boiler; also of the friends and connections of the old directorate; and, still more satisfactory, of many of those gentlemen who have been using the boilers, and, therefore, know something of their merits and of the Company as a sound and good investment. He regretted that the Stock Exchange quotation had not yet been obtained, but this matter could not be forced, and he hoped all the technical requirements of the Stock Exchange would be completed within a very short time, when a quotation would be given. As far as the Directors had seen of the Company's business, and the value of its productions, they were able to say with confidence that it exceeded their most sanguine expectations; also that they were very full of work, and were gradually extending their operations in new fields at home and abroad. In conclusion, he said that on the next occasion when they would have the pleasure of meeting the shareholders, he would certainly be able to give tangible proof that the Board have laboured to some purpose.

CROMPTON ELECTRIC SUPPLY COMPANY OF AUSTRALIA.

Directors: John Francis Albright, C.E., M.I.E.E., Carlton Fowell Tufnell, A.M.I.C.E., William George Whiffen. Australian Committee: John See, member of Legislative Assembly, Sydney, William Trotter, J.P., A. H. Whiffen.

Report of the Directors presented at the general meeting held at the offices, Mansion House-buildings, E.C., on Tuesday, 27th inst.

The Directors having now received from Sydney the certified statements of account made up to May 31, 1891, two years from the date of commencement of the Company's business, have pleasure in submitting the same to the shareholders, together with a balance-sheet and profit and loss account, made up to the same date. The Directors, however, regret to state that the Auditors report certain items in the Sydney accounts as being insufficiently detailed, and therefore they are unable to ask the shareholders to pass the accounts herewith as final. Since the last meeting of the shareholders, Mr. J. F. Albright has visited Sydney and other parts of Australia, where he examined thoroughly into the business, and made an exhaustive and satisfactory report thereon, expressing himself hopeful as to future increase. The Sydney committee have, with the accounts, sent home a report which is couched throughout in a sanguine and confident tone as to the position and prospects of the Company. Both of these reports can be seen upon application to the Secretary. A powerful syndicate has been formed in Sydney for the purpose of promoting a Bill in Parliament for the electric lighting of the city of Sydney. This Company holds shares in the syndicate, and by the latest advices there is considerable hope of the Bill being carried. Should the Bill pass, this Company will materially benefit, both as engineers and contractors, besides adding greatly to its credit and influence. Messrs. Crompton and Co., Limited, have recently granted to this Company, without payment for goodwill, the exclusive right to carry out electric work in New Zealand under their patents. Business has already resulted therefrom, and the prospects of future work are good. The net profits available for division, according to the accompanying accounts, after making full provision for bad and doubtful debts, and deducting the dividend paid in October last year, amount to £1,558. 3s. 6d. The Directors propose to distribute a further dividend of 2 per cent. for the year ending 31st May, 1890, making with the interim dividend already paid, a total of 8 per cent. for that year, and an interim dividend of 7 per cent. per annum for the second year to 31st May last, carrying the balance forward, pending the receipt of the details from Sydney required by the Auditors. In accordance with the articles of association, Mr. W. G. Whiffen retires from the Board by rotation, but being eligible, offers himself for re-election. The auditors, Messrs. Payne and Bankes, also offer themselves for re-election.

The following report of the meeting at which the above report was presented, has been supplied to us by the Secretary of the Company. Mr. J. F. Albright occupied the chair.

The **Secretary** (Mr. F. R. Reeves) having read the notice convening the meeting,

The **Chairman** congratulated the shareholders upon the improved position of the Company, as shown by the accounts before the meeting, which accounts, he regretted, however, the Directors were not able to ask the shareholders to pass as final, because some small matters of detail required by the London auditor had not yet been received from Sydney. He (the Chairman) had, however, no doubt as to the accuracy of the accounts, which were signed by the whole of the Sydney directors, and certified by an independent firm of public accountants in Sydney. Adverting to the promotion by the Company of a Bill in the New South Wales Parliament for powers to supply electricity in the city of Sydney, the Chairman stated that the Bill had already passed the committee, and it was hoped that they would be able to carry the Bill through, as if this were accomplished the financial results to the Australian Company were expected to be very large indeed, to say nothing of the important additional influence which the carrying out of such a scheme would bring to the Company. He concluded by moving that the Directors' report and statement of accounts be received and that the report of the Directors be adopted.

Mr. T. R. Tufnell seconded the Chairman's resolution, but spoke at some length expressing his regret at the Sydney committee not having supplied the whole of the information required by the London Board and Directors. The resolution was put to the meeting and carried unanimously, as was also a resolution declaring additional dividends of 2 per cent. for 1890, making 8 per cent. in all for that year, and an interim dividend of 7 per cent. for 1891.

The retiring director, Mr. W. G. Whiffen, was unanimously re-elected, and a resolution voting 50 guineas per annum each to the Directors for their services, the maximum sum which the Directors would agree to accept, notwithstanding a proposal to vote a larger figure, was also passed.

The auditors, Messrs. Payne and Banks, were re-elected, and the meeting closed with the usual vote of thanks to the Chairman and Secretary.

COMPANIES' REPORTS.

MONTEVIDEO TELEPHONE COMPANY.

The report of the Directors for the year ending July 31st last shows that, including the balance of £184 brought forward from last year, there is a profit of £4,970, after providing for all working expenses in Montevideo and London, and after writing off £115 for proportion of preliminary expenses and £20 for depreciation of furniture at head office and in Montevideo. The Directors, being influenced by a desire to strengthen the position of the Company, feel that the only course open to them is to recommend that the sum of £4,500, as advised by the Auditors, be added to the depreciation fund, and the balance of £470. 6s. 11d. be carried forward to next year. In view of the almost complete collapse of commerce in the River Plate during the year now completed, the Directors feel that there is cause for congratulation in the present position of the Company.

CITY NOTES.

City and South London Railway.—The receipts for the week ending October 25 were £756, as compared with £794 for the week ending October 18.

Western and Brazilian Telegraph Company.—The receipts for last week, after deducting 17 per cent. payable to the London Platino-Brazilian Company, were £3,708.

The Eastern Telegraph Company announce the payment by warrants on Nov. 2 next of interest for the half-year ending 31st inst. on their 4 per cent. mortgage debenture stock.

Change of Address.—Mr. Sidney à Court, A.M.I.C.E. and E.E., consulting electrical engineer, has removed from 6, Queen Anne's-gate, to 11, Little Queen-street, Westminster, S.W.

Indo-European Telegraph Company.—The Directors have declared an interim dividend for the half-year ended June 30 at the rate of 5 per cent. per annum, free of income tax, payable after November 1.

Consolidated Telephone Company.—The Directors have declared the usual interim dividends for the half-year of 6 per cent. on the preferred, and 5 per cent. on the ordinary shares, both less income tax, and payable on November 16.

Electric and General Investment Company.—At a Board meeting held on Wednesday, the Directors declared an interim dividend on the capital paid up on the ordinary shares at the rate of 20 per cent. per annum for the six months ending November 30, payable on that date.

Extension of Business.—Messrs. Andrews and Preece, of the Borough Mills, Bradford, inform us that they have purchased the electrical engineering business of Messrs. Cecil Wray and Co., 3, Albion-court, Bradford. Mr. Wray has accepted an appointment with Messrs. Andrews and Preece.

Patent Agency—Messrs. David Young and John T. Knowles announce that, having resigned their appointments with Messrs. Haseltine, Lake, and Co., patent agents, they have commenced business on their own account, under the firm or style of D. Young and Co., at 11 and 12, Southampton-buildings, W.C.

West India and Panama Telegraph Company.—For the half-year ended June 30 last, the Directors propose dividends at the full rates on the first and second preference shares, with a distribution of 1s. per share on the ordinary. The sum of £2,000 is to be placed to reserve, leaving £5,255 to be carried forward.

Dissolution of Partnership.—Messrs. Frederick Brown and Howard W. Bishop, trading as the Walsall Electrical Company, 57, Bridge-street, Walsall, have dissolved partnership. All moneys due to the firm will be received, and all outstanding accounts will be paid by Mr. Frederick Brown, who is carrying on the business.

Western and Brazilian Telegraph Company.—The Directors have decided, after placing £25,000 to the reserve fund, and £6,233. 10s. to the debenture redemption fund, to recommend at the forthcoming meeting a dividend of 6s. per share, free of income tax, or at the rate of £4 per cent. per annum, for the six months ended June 30 last, being the same as for the corresponding period.

Crompton and Company.—An extraordinary general meeting of this Company is to be held at the offices, Mansion House-buildings, E.C., on Tuesday next, at 3 p.m., to consider and pass a resolution increasing the capital by the issue of 10,000 additional preference shares of £5 each. This is with the view of obtaining more working capital necessitated, so say the Board, by the continued growth of the business. Five thousand of the above shares are to be offered first at par, and the second 5,000 reserved for a later issue at a premium.

PROVISIONAL PATENTS, 1891.

OCTOBER 19.

17836. **Improvements in and relating to electric meters.** Richard Norman Lucas, 8, Featherstone-buildings, High Holborn, London.

17849. **Improvements in electric light fittings.** James Aram Lea, James Francis Lea, and Arthur Henry Lea, Pengwerne Works, Shrewsbury, Salop.

17852. **Improvements in telephone apparatus, or in telephonic instruments, and in coin-controlled mechanism for use with, or in connection with same.** Frederick John Palmer, Florenville, Dawlish, Devonshire.

17855. **Improvements in wall plugs for electric lighting.** William Thomas Pressland, 18, Fulham-place, Paddington, London.

17867. **Improvements in the means for preventing short-circuiting in electrical apparatus fittings, lamp-holders, etc.** Henry Charles Gover, 61, Tierney-road, Streatham-hill, Surrey.

OCTOBER 20.

17907. **Improvements in electric signalling.** Alan Archibald Campbell Swinton, 66, Victoria-street, London.

17916. **Improvements in dynamos.** Joseph Shepherd and Thomas Savile Watney, 2, East-parade, Leeds.

17965. **An improved mode of and apparatus for transmitting and recording electrically autographic messages, signals, and markings.** Philip Arthur Newton, 6, Bream's-buildings, London. (Elisha Gray, United States.) (Complete specification.)

17971. **Improvements in electric clock winders.** James William Du Laney and Charles Franklyn Du Laney, 4[illegible], Chancery-lane, London. (Complete specification.)

17974. **Improvements in insulation for electric conductors.** (Charles Thellismar Snedekor, United States.) Harry Allen, 18, Buckingham-street, Strand, London.

17994. **Improvements in and relating to electric batteries.** Bernhard Scheithauer, 45, Southampton-buildings, London. (Complete specification.)

18002. **Improvements in railway electric block signal systems.** John La Burt and William Herman Agricola, 53, Chancery-lane, London. (Complete specification.)

OCTOBER 21.

18011. **Improvements in telephone switchboards.** Alfred Whalley, Helsby, near Warrington, Cheshire.

18043. **Improvements in chain bolts.** William George Gooch, King's Heath.

18059. **Electrical counting apparatus.** Frederick William Golby, 36, Chancery-lane, London. (Louis Goubert, France.)

18080. **Improvements in fire alarm telegraphs.** James Hanley Greenwood, 28, Hatton-garden, London.

18093. **New or improved automatic circuit-closing device for electric fire alarms.** Ernest James Elkington, Norfolk House, Norfolk-street, London. (The Compañia Electricista contra Incendios, Spain.) (Complete specification.)

OCTOBER 22.

18097. **Improvements in galvanic batteries.** Calvin Nathaniel Souther, 45, Southampton-buildings, London. (Date applied for under Patents Act, 1883, Sec. 103, March 23, 1891, being date of application in United States.) (Complete specification.)

18143. **Improvements in the method of mounting storage battery plates.** Henry Alexander Mavor, William Arthur Coulson, and Sam Mavor, 62, St. Vincent-street, Glasgow.

18162. **Improvements in electrical lamp and other fittings.** Henry Charles Gover, 28, Southampton-buildings, London. (Complete specification.)

18179. **Improvements in or relating to the coupling of dynamo-electric machines in parallel.** Albert Gay and Robert Hammond, 46, Lincoln's-inn-fields, London.

OCTOBER 23.

18199. **Improvements in and connected with telephone exchange switches.** Alexander Marr, 70, Market-street, Manchester.

18205. **Improvements in dynamometers or force measures.** George Richard Postlethwaite, 124, Park-road, Aston, near Birmingham.

18207. **Improvements in electric telephones.** Arthur Thomas Collier, 70, Market-street, Manchester.

18251. **Improvements in electricity meters** Siemens Brothers and Co., Limited, and Francis Gibson Baily, 28, Southampton-buildings, London.

18256. **An improved process for the electro-deposition of metal upon the surface of glass, porcelain, china, earthenware, and other materials.** Arthur Stephen Ford, 35, Chancery-lane, London. (Henri Pottier, France.)

OCTOBER 24.

18280. **Improved submarine cable grapnel.** Walter Claude Johnson, 28, Southampton-buildings, London.

18285. **Improvements in electric switches.** Algernon Burton, Cobden-buildings, Corporation-street, Birmingham.

18290. **Improvements in switches for electric lighting.** Andreas Peter Lundberg, 18, Fulham-place, Paddington, London.

18304. **An improved device for trueing the commutators of dynamo-electric machines.** Hugo Hirst, 11, Furnival-street, Holborn, London.

18318. **An improved electrical safety switch.** George Lewis Hall, 106, Victoria-chambers, Chancery-lane, London.

18348. **Improvements in or connected with the distribution of electricity.** Thomas Parker, John Harold Woodward, and Edmund Scott Gustave Rees, 47, Lincoln's-inn-fields, London.

SPECIFICATIONS PUBLISHED

1880.

583. **Electric railways, etc.** Siemens. (Siemens.) (Second edition.) 8d.

1882.

3380. **Electric haulage system.** Ayrton and Perry. (Second edition.) 11d.

1890.

18695. **Dynamo-electric machines.** Holmes. 6d.

19049. **Electric lighting appliances.** Muirhead. 6d.

1891.

10260. **Electric signalling, etc., in trains.** Shiels and Elliott. 8d.

14322. **Electric light holders.** Savage. (Savage.) 6d.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Brush Co.	—	3⅛
— Pref.	—	2¼
India Rubber, Gutta Percha & Telegraph Co.	10	19⅝
House-to-House	5	5
Metropolitan Electric Supply	—	10⅛
London Electric Supply	5	2¼
Swan United	3¾	5⅛
St. James'	—	8½
National Telephone	5	4½
Electric Construction	10	6⅞
Westminster Electric	—	6⅛

NOTES.

Newcastle.—The plant of the Newcastle Electric Supply Company is being extended.

Khotinsky Lamps.—Captain Khotinsky has gone to Brazil to establish a manufactory of incandescent lamps in that country.

Train Lighting in Australia.—The South Australian Government is about to reintroduce electric lighting on its inter-colonial lines.

African Atlantic Cables.—The French papers announce that a submarine cable will shortly be laid between Pernambuco and Senegal.

Crystal Palace Exhibition.—We are pleased to hear that some of the more notable exhibits at the Frankfort Electrical Exhibition will be transferred to the Crystal Palace Exhibition.

Telephones in Belgium and Holland. — The directors of the Belgian and Netherlands Telephone Companies are considering a scheme for connecting the systems of the two countries.

Fire Alarms.—The tender of F. E. Stuart, of Twickenham, has been accepted for fitting at the Halifax Fire Brigade Station an electric call system from the watchroom to firemen's bedroom for the sum of £40.

Japanese Telegraphs.—The Great Northern Telegraph Company state that the Japanese land lines which were interrupted beyond Hiogo and Osaka on October 28, owing to an earthquake, have now been restored.

Rhyl.—At the Rhyl Improvement Commissioners' meeting on Monday, a motion by Mr. Greenhalgh that the cost be ascertained of a plant from an electric lighting company to light the streets, promenade, and shops, was defeated.

Torquay.—At Torquay Town Association, on Monday, a letter was read from Mr. E. Appleton, giving details of electric tramways in Switzerland; but the meeting did not consider a scheme of electric tramways to be practicable for Torquay.

Institution.—The Institution of Electrical Engineers will open the coming season with a paper on "Description of the Standard, Volt, and Ampere Meter used at the Ferry Works, Thames Ditton," by Captain H. R. Sankey (late R.E.), member, and F. V. Andersen, associate.

Whitechapel.—Tenders are to be invited by the Whitechapel Board of Works for lamps in various thoroughfares, and a special meeting of the Board will be shortly held to consider the question of applying for a provisional order for the purpose of lighting the district by electric light.

Isle of Man Exhibition.—An area of about 20 acres has been secured at Belle View, Douglas, for an international exhibition to be held in the Isle of Man in June next year. Mr. Henry W. Pearson, of Liverpool, is general manager. The exhibition is be lighted throughout with electric light.

Mexican Tramways.—Work under the Violante Concession for a railway from Niño Perdido to Coyoacan and the Pedreral quarries has been commenced. The contractor is Mr. Estanislao Zayas. Mules will be employed at first on the new line, and it is contemplated afterwards to employ electricity.

Paris.—The demand for the electric light at the municipal station of the Halles Centrales has now exceeded the supply. It is hoped to obtain an authorisation for purchase of a set of accumulators, until which time the applicants are at liberty to be supplied by private companies even within the municipal district.

Darenth Asylum.—The Metropolitan Asylums Board, on the recommendation of the Darenth Asylum Committee, accepted the tender of the Jensen Electric Bell Company (Messrs. Woodhouse and Rawson, proprietors) for maintaining in efficient order all the electrical apparatus, at £75 a year, for a term of three years.

Newcastle Library.—The Newcastle public library is being fitted throughout with electric light at the cost of £600. The contract has been given to the Electrical Supply Company, Pandon, and the installation will be carried out in direct consultation with Mr. Heaviside, chief of the Newcastle Post Office engineering staff.

Berly's Directory.—Messrs. Alabaster, Gatehouse, and Co. announce that they have purchased the copyright of "Berly's Electrical Directory," which will be henceforward published at the *Electrical Review* office. Mr. J. F. Chase, who for several years past edited and managed this publication, continues his connection as heretofore.

Barnton Park.—The first sod of the railway to Barnton, near Edinburgh, was turned last week by Lady Maitland. Barnton will, when the railway is completed, be a favourite suburb of Edinburgh. About 400 villas are shown on the plan, and the estate is regarded as a favourable one for a central supply of electric light.

Appointment.—Mr. Clement Leaper, writing with reference to our notice last week of his appointment at Taunton, says he was never engaged at the City Guilds Institution, as might appear from that note, but holds teacher's certificates (honours) in electric lighting and transmission of power, electro-metallurgy, and photography.

Mont Blanc Observatory.—M. Janssen has reported to the Académie des Sciences with reference to the proposed observatory on Mont Blanc, that he has sunk two zigzag paths nearly 30ft. deep without meeting rock. The cuttings are to be continued next summer, and if rock is not found M. Janssen thinks an observatory might be erected on the snow.

Telephone at Gravesend.—At the Gravesend Town Council meeting, a letter was read from the National Telephone Company stating that any person not a subscriber would be able to go to their call-rooms, and by payment of 3d. speak to any subscriber, and, further, that, if found practicable, a fee call-room would be established in the surrounding villages.

Wood Pulp Bearings.—Bearings constructed of compressed wood pulp are the outcome of some ingenious mechanic. Combined with graphite they require no lubrication, and greatly reduces the friction. The compound can be cut or drilled like metal, and is almost as hard. A dynamo is stated to have been fitted with these bearings with satisfactory results.

Coast Telephones.—Telephonic communication has now been successfully established between Mount Wise, Devonport, the breakwater fort in Plymouth Sound, and Fort Picklecombe, on the western shore of the harbour. The work has been carried on under great difficulties owing to the bad weather, a large pinnace having been dashed upon the rocks and badly damaged.

Nelson (Lancs.).—The Nelson Gas Committee have had before them the draft agreement proposed to be entered into by the Corporation and customers as to the supply of the electric light. This was approved, and the committee resolved that the hours of supply be determined by the sub-committee. The gas engineer was instructed to prepare at once a specification for electric light purposes.

Finchley.—The Finchley Local Board have decided to take steps to apply for a provisional order for electric lighting. The Electric Lighting Committee has visited some of the metropolitan generating stations, and an elaborate report has been prepared by the engineer and surveyor to the Board, Mr. F. Smythe, who recommends the transformer system with an alternating current, the estimated cost being £19,000.

Artistic Lampposts.—Great outcry has been made in Paris over the arc lampposts in the Place du Carroussel, which have been described as "gibbets," out of place with the beautiful architectural surroundings. They are to be ornamented and gilded. At the Palais de Justice the lamps have lately been improved in a highly ornate manner, both as to the posts and the lanterns on either side of the great staircase of the Law Courts.

Books Received.—"The First Book of Electricity and Magnetism, for the use of Elementary Science and Engineering Students," by W. P. Maycock, M.I.E.E. London. Whittaker and Co. Price 2s. 6d. "Popular Electric Lighting, being Practical Hints to Present and Intending Users of Electric Energy," by Captain E. Ironside Bax, general manager of the Westminster Electric Supply Company. Biggs and Co. Price 2s.

Inverness.—The electric light seems to have been a test question at the meeting of electors at Inverness on Monday. Most of the candidates were in favour of the scheme, while some expressed uncertainty as to the extent of the water supply and the wisdom of the experiment. The general sense of the meeting was fully in favour of the steps taken by the Police Commissioners to enquire fully into the scheme for electric lighting before spending £10,000 on gaswork extensions.

Southampton.—There have been remarks passed on the wild tendering for city offices in the electric lighting trade, but the recent result of tenders for the Southampton Harbour Board would seem to be a noticeable case of misjudgment. The tenders were for electric light fittings for the pier (Messrs. Lemon and Poole, engineers); that of Mr. F. Shalders, Southampton, for £575, was accepted, being the lowest of 15 tenders, of which the highest was £1,909, three and a half times as much.

Croydon Tramcars.—At the Croydon County Council meeting last week a letter was read from the Electric Tramcar Syndicate asking consent to run electric cars on the Jarman system with storage batteries on the lines of the Croydon Tramway Company. Councillor Foss handed round a photograph of the car, and pointed out that the running was experimental and for a few weeks only. A resolution was passed giving consent without prejudice to the rights of the Corporation and subject to withdrawal.

Colchester School of Art. — The school of art at Colchester was temporarily lighted by electric light at a lecture on "The Wonders of Colour," given by Mr. Charles Benham on October 27. The effect was greatly admired, and the question of the electric lighting of the school throughout has been mooted by Mr. Paxman and supported by the committee. The successful effects realised in painting from the life in the evening following the lecture completely proved the need for this superior quality of artificial lighting for art purposes to the obvious benefit of the school.

Commission.—In the Queen's Bench Division on Wednesday, the case of Muirhead *v.* the Debenture Guarantee Investment Company, Limited, came before Mr. Justice Denman and a special jury. It was an action to recover commission for the introduction to the defendants of the St. James's Electric Light Company, who required capital, which was supplied by the defendants. Mr. Finlay, Q.C., was counsel for the plaintiff, and Mr. Jelf for the defendants. After the action had made some progress a settlement was arrived at, and judgment was entered for the plaintiff for £1,200, without costs.

Menagerie Lighting.—Mr. Frank Bostock, so we are told, has had a complete electric light installation fitted up for his travelling menagerie, and his lead has been followed by both his brothers. Such, we hear, is the success that these installations have led to nine other orders being given to the same firm within a few weeks. Portable engines, driving the dynamo by a belt, are stated to be used, but such an arrangement would necessitate two portable waggons. One of Hayward Tyler and Co.'s portable plants on one carriage, as designed for the Kidderpore Docks, would evidently be more suitable to this purpose.

Electro-Chemical Transformer.—A new idea in transformers is the invention of Mr. Turner D. Bottome, of Hoosick, N.Y. Instead of using mechanical or ordinary electrical means of transforming currents, he uses the chemical reactions to change alternating currents in a direct current. The transformer has four asymmetrical conductors, each consisting of a containing vessel filled with an electrolyte of sulphuric acid or a sulphate with an electrode of inoxidisable material and another electrode of aluminium. These are so connected together that currents of one direction only can pass through two of the conductors, and currents of the other direction through the other conductors; both join at common poles to form a direct current.

Three-Phase Incandescent Lamps.—Herr Dolivo-Dobrowolsky has been carrying out some curious and interesting experiments upon the effect of the three-phase current with incandescent lamps. In these circuits the motors are connected to each of the three wires, but the lamps may be placed in parallel across two wires—between the neutral point and any of the three conductors. All three conductors can also be used by having a three-ended filament. Mr. Dobrowolsky has accomplished this by having some specially constructed lamps made, having a V-shaped filament with a third branch attached to the point. The three filaments are of the same diameter, a result of the fact that the total of the strength of a three-phase current is nil.

Curious Accident at Chelmsford.—An accident which recently occurred at Chelmsford, and which has been somewhat widely reported, is interesting in one respect—that it shows that the use of overhead wires may in some cases increase the safety of the public instead of being dangerous, as has been so often stated by their opponents. A runaway omnibus passing through the narrow street which leads to the station came in contact with one of the arc lampposts with such violence as to break off an exceedingly massive casting at the ground line. If the wires had been underground the pole would have fallen into the street and probably caused serious damage. As it was, although broken short off, it was held upright by the system of overhead conductors attached to it, and no damage was done to anything but the arc lamp itself.

Worcester.—The recent canvass by Mr. Oswald Swete of the citizens of Worcester as to their willingness to take the electric light, resulted in promises equivalent to about 14,000 10-c.p lamps being provisionally given. The price suggested was 7d. a unit, equal to gas at 4s. 6d. per 1,000 feet. Many of the returns were marked "provided a storage system were used," and this feeling seemed to be very general. The cathedral would require 2,000 lamps to light it properly. The post office wanted a considerable reduction in price. The Victoria Institute would require current for their laboratories and motors. The railway company would enter into a contract at a fixed price per lamp per year. Mr. Swete was paid a fee of 15 guineas for his services, and the question was referred to a sub-committee with the hope that something practical would be done.

Presentation.—Last week Mr. T. A. F. Cutler, on behalf of the whole staff of the Bath central electric lighting station, presented Mr. B. Deakin with a handsome writing and stationery cabinet, also an amber and silver-mounted briar pipe in case, which bore the following inscription: "Bath, 1891—Presented to Mr. B. Deakin, from the staff of the Bath Electric Light Works, with their kindest regards and best wishes for his future success." Mr. Deakin was from 1882 to 1890 in charge of the Brush Company's Cardiff lighting station and South Wales business, and was appointed senior engineer at the Bath works in January, 1891, which position he is now vacating to undertake the charge of the extensive lighting station which the Brush Electrical Engineering Company are at present equipping for the City of London Electric Supply Company.

Edinburgh Tramways.—With reference to the continuance of the Edinburgh tramways concession, the Corporation have had a consultation with the directors of the Edinburgh Tramway Company, and suggested the *statu quo* should be maintained for another three years. The tramway company asked for 10 years, not believing that by the end of three years the question of mechanical traction would be sufficiently settled. By the end of ten it was expected great advances would be made in tramway propulsion, and the question of cable *versus* electricity fully settled. It is to be hoped it will be settled long before this time now that the electric tramways have fully got a start in Great Britain, but the Edinburgh Corporation seemed to be satisfied, and the longer period will probably be given. A draft Bill for extension and embodying a subvention of £3,000 a year offered by the tramway company for the use of the streets, is to be submitted at a future meeting.

Incandescent Lamp as Seismograph.—In laboratories where stability is of consequence—such as photographic or physical laboratories—it is usual to test the state of the room as regards vibrations by a basin of mercury. M. F. Leconte, a Belgian scientist and photographer, points out that an incandescent lamp forms a far more delicate form of instrument for this purpose. It should be an unblackened lamp with the vacuum preserved; in fact, a new lamp, say, of 100 volt—8 c.p. M. Leconte placed a lamp having a looped filament on the pillar to be tested, a candle behind, and a field-glass in front to observe the vibrations. Steps and jolts on the floor were perfectly indicated by movements of the filament, when the basin of mercury remained perfectly unaffected. The extreme delicacy of the filament to vibration is very well known, and the employment of this property for testing photographic studios and astronomical observatories may possibly prove useful.

London County Council Inspector.—The Highways Committee of the London County Council have had to consider the appointment of meter inspector in place of Mr. W. Arnot, resigned. In response to an advertisement, 57 applications were received and were carefully considered. Among these eight candidates were selected as eligible, and from these they selected Mr. Arthur Edward Rossiter, whom they recommend to be appointed in the engineer's department on probation for 12 months, the appointment to be subject to confirmation at the end of that time. The salary is £200 a year. The duties to be discharged are those of an inspector under the Electric Lighting Acts and Orders, and such other duties as required. The appointment does not include pension or superannuation, but includes necessity for agreement to any scheme the Council may adopt with respect to insurance for pension or superannuation. The appointment was confirmed.

Society of Arts.—The arrangements for the meetings of this society during the ensuing session have just been announced. The first meeting will be held on Wednesday, November 18, when the opening address will be delivered by the Attorney-General, chairman of the council. On the following Wednesday evenings, previous to Christmas, papers will be read on "The Measurement of Lenses," by Prof. Silvanus P. Thompson; on "The World's Fair at Chicago in 1893," by Mr. James Dredge; on "Secondary Batteries," by Mr. G. H. Robertson; and on "Spontaneous Ignition of Coal and its Prevention," by Prof. Vivian Lewes. Among the courses are lectures on "Electrical Distribution," by Prof. Forbes; "The Uses of Petroleum in Prime Movers," by Prof. W. Robinson. A special course of lectures has also been arranged, under the Howard Bequest, on "The Development and Transmission of Power from Central Stations," by Prof. W. Cawthorne Unwin, F.R.S., commencing shortly after Christmas.

Institution Annual Dinner.—Amongst the guests who have accepted invitations to be present at the annual dinner of the Institution of Electrical Engineers on November 13 are: the Postmaster-General (Sir J. Ferguson, Bart., G.C.S.I., M.P.); the Inspector-General of Fortifications (Major-General Grant, C.B., R.E.; Sir G. G. Stokes, Bart., M.P. (late president of the Royal Society), Sir John Pender, K.C.M.G., Sir Thomas Blomefield, Bart. (Board of Trade), Captain W. J. L. Wharton, R.N., F.R.S., (hydrographer to the Admiralty), Mr. H. J. Chaney (Standards Department, Board of Trade); the presidents of the following societies: the Institution of Civil Engineers, the Institution of Mechanical Engineers, the Iron and Steel Institute; Mr. Harrison Hayter, Mr. Alfred Giles, M.P., Sir Benjamin Baker, K.C.M.G., vice-presidents of Institution of Civil Engineers; Dr. William Pole, F.R.S.S. London and Edinburgh, hon. secretary Institution of Civil Engineers, Colonel W. Haywood, engineer to the Commissioners of Sewers.

Royal Scottish Society of Arts.—The committee of this society have awarded the following prizes (amongst others) for communications made during last session: Dr. R. Milne Murray, for paper "On an Electrical Bench for Physiological Research," Keith prize, value £21; to F. Grant Ogilvy, for communication "On the Telegraph Exhibits at the International Exhibition," accompanied with the society's honorary silver medal; to E. Manville and J. G. Statter, for paper "On the Telpher and Electric Railways at the Exhibition and on Electrical Traction," accompanied with Keith complimentary silver medals; to A. R. Bennett, for paper "On Electrical Navigation," accompanied with the society's honorary silver medal; to M. Holroyd Smith, for paper "On Electrical Traction," accompanied with the society's honorary silver medal; to Prof. A. B. W. Kennedy, for paper "On a Description and Comparison of the Systems of Electric Lighting at present in use in London," accompanied by the society's honorary silver medal.

Lifeboat Communication.—Sir Edward Birkbeck, who is chairman of the Royal National Lifeboat Institution, has a forcible letter in the *Times*, on Monday, with respect to the terrible waste of life and goods due to the want of telephonic or telegraphic communication to the lifeboat stations. He says he intends to move a resolution in Parliament next session, as follows: "That, with a view to the better prevention of loss of life and property in cases of shipwreck, and to give speedy information to lifeboat authorities and rocket apparatus stations, in the opinion of this House it is desirable that telephonic and telegraphic communication should be provided by Government between all the coast guard stations and signal stations on the coast of the United Kingdom, and on such parts of the coast where there are no coast guard stations, the postal telegraph offices nearest to the lifeboat stations." He adds that it has been estimated that an expenditure of £100,000 would be sufficient to establish such a system—a mere bagatelle when the vast importance of the object is considered.

Catalogue.—We have received a copy of their catalogue from Messrs. S. Z. de Ferranti and Co., Limited, of Charterhouse-square, London, containing particulars and illustrations of this firm's well-known dynamos and mains. Some very capital woodcuts show one of these Ferranti alternators, with exciting dynamos mounted on the same axle, and fitted for rope gearing. These machines are made for any tension—from 1,000 to 3,000 volts for ordinary station work, to supply from 1,500 to 30,000 10-c.p. 35-watt lamps. The alternations of current in these machines are 5,000 cycles per minute, or 10,000 phases. They are rated to have exceptional margin of safety, and have frequently been run at various stations at 50 per cent. over normal output. Alternators for coupling direct to high-speed engines are constructed for 4,000 complete alternations, 350 or 400 revolutions. Complete installations of sub-station transformers, house transformers, station switches, and synchronising gear are shown, together with fuses, and the celebrated Ferranti mains, which we fully illustrate elsewhere.

Electric Illuminations at Worcester.—The festivities in connection with the return of the Earl and Countess of Dudley to Worcester last Saturday after their marriage, was made the occasion of an effective electric lighting display at the Worcester Cathedral. One of the Naval Exhibition search-lights was placed on the roof, together with four arc lamps in positions at other points between the pinnacles. The prominent position of the cathedral made the operation of the search-light very effective. The work was undertaken by the British Electric Installation Contractors, of London and Worcester, under the superintendence of Mr. Morgan Williams, their consulting engineer; and the staff of Mr. Ronald Scott, of Acton, carried out the erection of the plant, which consisted of a powerful portable engine driving two dynamos, the whole being placed in a portion of the enclosure at the back of the cathedral. Elsewhere in the town accumulators were used for arc lighting outside a tradesman's shop, this work being also carried out by the same company, under Mr. Oswald Swete, acting engineer to the local electric company.

Christiania.—Tenders in all from 20 different firms were received for the Christiania electric lighting station, of which 13 were for the whole installation and the others for special parts. For the whole installation tenders were received from the Edison General Electric Company, New York; Crompton and Co., London; Siemens Bros., London; Electric Construction Company, Wolverhampton; Siemens and Halske, Berlin; Schuckert and Co., Nürnberg; Thomson-Houston International Electric Company, Hamburg; Helios Company, Cologne; Continental Edison Company, Paris; O. L. Kummer and Co., Dresden; Sharp and Kent, Westminster; Woodhouse and Rawson, Limited, London; Chrom-Accumulator Company, Berlin. For the boilers only, the firms: Düsseldorf-Ratingen Company, Ratingen; Babcock and Wilcox, New York; Gohrig and Leuchs, Darmstadt; L. and C. Steinmüller, Gummersbach. For the mains only: Callender's Bitumen Company, London. For the steam engines only: J. and A. Jenssen and Dahl, Christiania. For the dynamos and fittings only: Mather and Platt, Manchester. The contracts are to be awarded within six weeks from October 10.

Bournemouth Telephone.—The burnt-out telephone exchange at Bournemouth has been again temporarily started, to the great satisfaction of the subscribers, who have been living telephonically in silence for over a week. Mr. Mackenzie Williams, district superintendent of the Western Counties Telephone Company, and a staff of skilled workmen, were at work almost day and night repairing the damage and endeavouring to arrange for a temporary installation. The large switchboard that was damaged has to be replaced by one from Chicago, and in the meantime a smaller board, consisting of three single-line switches of 100 subscribers each, has been fixed, awaiting the arrival of the multiple board from the States. On Tuesday morning the temporary installation was complete, and three of the operators at once began to ring up the subscribers. The present communication is only temporary, but the regular exchange will be ready in a few weeks. It speaks highly for the company that within so short a time they should have restored order out of the chaos which reigned a fortnight ago, and given their subscribers as soon as possible the benefit of using the telephone in the meantime.

Fowler-Waring Cables.—The Fowler-Waring Cable Company, 32, Victoria-street, and North Woolwich, send us their new illustrated catalogue. The cables are of two classes, "lead-covered" and "lead-foiled." The former are sheathed in solid drawn lead, and are for use in underground conduits, factories, public works, and steamships, or wherever great strength is requisite. The latter are sheathed in a light covering of lead, and outwardly protected by a fibrous braiding. The cables are all covered by means of special machinery for lead covering, and are free from pores and cracks. The insulation is very high, ranging from 1,000 to 5,000 megohms at 75deg. F., and all cables are tested after prolonged immersion with high-pressure currents. Tables of sizes and prices are clearly given, not only for the special cables, but also for flexibles and circular braided cords for pulleys. Jointing materials and tools are illustrated, and also the various methods of jointing. The lead joints are specially described with very full particulars and cuts. Aerial cables are separately dealt with, and the hooks and suspending wires shown. Tables of sizes, specific gravities, melting points, and relative conductivities of various metals complete a very useful catalogue.

Lighthouses.—The question as to whether the authorities have done altogether wisely in substituting the electric light for oil in lighthouses is one which is agitating minds in the marine world. There seems to be in some quarters a decided view to the contrary, and petitions, as has been reported, have been presented to Trinity House upon the subject by shipmasters who find that the absence of penetrating power in fog is a serious disadvantage, the light being least useful when most required. A lighthouse is not required to light the way of a ship, but to afford a fixed point or landmark for guidance. The penetrating power is therefore more important than mere strength of light. The question is being further taken up by French naval engineers. It would certainly seem that with the enormous surplus of lighting power we get in the electric arc that means are not impossible for converting or lowering a portion of this merely illuminating power into penetrating power, and so satisfy a very legitimate objection to the electric light for lighthouses. It seems to us that there should be little difficulty in obtaining a yellower light in the arc, and would suggest that previously saturating the lighthouse carbons in a sodium solution, or even of common salt, would produce the desired effect. With such important risks at stake, the matter is one that ought not to be left without full and adequate discussion and test.

House Lighting at Newmarket.—The Earl of Ellesmere has, we understand, decided to light the large private house and training establishment which he is building on his estate at Newmarket, the contract having been entrusted to Messrs. Ernest Scott and Mountain, Limited, Newcastle-on-Tyne. The installation will be of a very complete description, and will consist of a horizontal engine and locomotive boiler, the engine being fitted with automatic expansion gear, and capable of working up to 30 i.h.p. A Tyne dynamo, specially wound either for running as a compound-wound machine when feeding the lamps direct, or as a shunt-wound machine when charging the accumulators, will be driven from the engine, and will supply current to a set of accumulators capable of running 100 16-c.p. lamps for 10 hours, or the dynamo will feed 200 lamps direct. It is also proposed to utilise the engine for pumping, cutting chaff, and other purposes. The total installation when complete will consist of about 260 16-c.p. incandescent lamps, 100 of the lamps being placed in the house, and the remainder in the stables and stable departments. It is proposed to supply the house and stable lamps by independent circuits, so that the light on either circuit can be controlled from the dynamo-room. This installation when completed will be one of the most complete private house plants installed, and we hope later to be able to give a full description of the installation.

Sheffield.—The introduction of the electric light supply into Sheffield is within sight of achievement. The Corporation, at their meeting last week, had before them the question of the application of the Sheffield Telephone Exchange and Electric Light Company for a provisional order for the supply of the light to the town, and it was decided by the Council to support the application. The company has already a considerable private business, using Mordey alternators and Thomson-Houston arc dynamos. The decision of the Sheffield Town Council was by no means unanimous, 22 being for and 18 against, while 12 members stood out as neutral, the large number of non-voters being probably explained by the fact of their interest in the local gas company. A panic occurred in this town, with regard to gas shares, in early days of electric light when Edison's lamp was "boomed," but the local papers recall the fact that those who sold lost, while the shrewd bought, and deprecate any expectation of loss by gas shareholders by reason of the added use of gas for other purposes. It may be, certainly, that in Sheffield the introduction of the electric light may prove a veritable bonanza for the gas company. When theirs is the "light that failed" them, they will have to strive with might and main to secure pastures new for their products, and this may very well be in the supply of heating-gas to the innumerable industries of the smoky town. Sheffield is beautifully situated on the edge of the Derbyshire hills, and if the sulphurous clouds of smoke could be raised by the extensive commercial supply of heating-gas by the gas company, the inhabitants will have double cause to be grateful to the electric light.

O.S.A. Annual Dinner.—The seventh annual dinner of the Old Students' Association of the City and Guilds of London Institute took place on Saturday evening last at the Holborn Restaurant. The event must be chronicled as the most successful gathering of the kind that the association has yet held. Among the guests present were J. Shoppee, Esq., and G. Baker, Esq., members of the committee of the Technical Colleges; Musgrave Heaphy, Esq., C.E.; F. H. Webb, Esq., secretary of the I.E.E.; while a letter of apology was read from W. H. Preece, Esq., F.R.S., who was unable to attend through unexpected absence from London. The president, W. B. Esson, Esq., took the chair. The following gentlemen proposed and responded to the various toasts: Mr. Ll. B. Atkinson, Prof. Silvanus P. Thompson, F.R.S., Mr. Albion T. Snell, W. E. Sumpner, D.Sc., Mr. Baker, Mr. Reginald J. Jones (hon. secretary), Mr. H. Newman Laurence, and Mr. F. H. Webb. The annual report was read, and showed a satisfactory state of affairs both as to numbers and finance, and the committee look forward to a session of increased usefulness. The medal which is given by the association for the best paper of the year was awarded to Mr. Ernest B. Vignoles for his paper, entitled "Some Researches in Electromagnetic Induction." During the evening a most enjoyable musical programme was rendered, Messrs. Tingey and Fitzgerald singing, Mr. Gibson reciting, and three 'cello solos rendered by Mr. Bucknall, while Mr. C. G. Lamb accompanied on the piano. The attendance at the dinner was excellent, every seat being occupied. The hon. secretary (Mr. Reginald J. Jones) informs us that there are several gentlemen awaiting election at the next general meeting, and that membership application forms may be obtained from him on application, addressed care of Messrs. Woodhouse and Rawson United, Limited, 88, Queen Victoria-street, E.C.

Obituary.—The many friends of Mr. William Fereday Bottomley, late manager of the Dublin Telephone Exchange, will hear with regret of his death, which occurred at his residence, Booterstown, Dublin, on the 30th ult. He had passed the crisis in a severe attack of typhoid fever, and was on the road to recovery when a fatal attack of congestion of the lungs supervened. Mr. Bottomley commenced his career some 37 years ago in the service of the old Magnetic Telegraph Company. On the purchase of the telegraphs by the Government he joined the telegraph staff of the Lancashire and Yorkshire Railway Company. Subsequently, he undertook the management of the Manchester district for the Indo-European Company, which he afterwards resigned to become one of the pioneers of practical telephony, and it was under his supervision that probably the first telephonic trunk lines in this country were erected. These were between Manchester and Stockport and Manchester and Oldham, and in this connection it is interesting to note that in these lines the now well-known "twisted wire" system, of which Mr. Bottomley, the late Mr. Charles Moseley, and Mr. W. E. Heys were the first patentees, was first employed. As manager for Mr. Moseley, Mr. Bottomley popularised the telephone in his district at an early date, and a telephone exchange which Mr. Moseley was about to establish met with such great promise of success, that the directors of the late Lancashire and Cheshire Telephone Exchange Company became convinced of the danger of this opposition, and, before a mile of line was erected, they interposed and bought up Mr. Moseley's rights and property. Mr. Bottomley then joined the National Telephone Company as their London superintendent, but a few months afterwards the resignation of Mr. Butterworth having left the management of the Dublin Telephone Exchange vacant, Mr. Bottomley was appointed to the office, which he held and filled with great success until his death. Mr. Bottomley died at the comparatively early age of 51, and leaves a widow and several children.

UNDERGROUND MAINS.—IX.

FERRANTI MAINS.

Among the various systems of mains for the distribution of electricity few are more important, and certainly none are more interesting, than the celebrated Ferranti mains (of which the first public description was given in this journal, June 20 and September 19, 1890). Mains for the use of 2,000 volts having been in use for transformer distribution some years, Mr. S. Z. de Ferranti, then chief engineer to the London Electric Supply Corporation, and the designer of the whole system there used, boldly determined to transmit current at the enormous pressure of 10,000 volts to London from the company's generating station at Deptford, a distance of 7½ miles lower down the River Thames. The difficulty of accomplishing this was the more enhanced in that it was necessary to lay these mains to a considerable extent underground, whereas the previous high-pressure distribution had been principally overhead. Several systems of ordinary electric cables were first tried at 5,000 and 10,000 volts, but none of these gave sufficient promise of fulfilling, over a considerable length of time, the conditions necessary for a large system of distribution, such as contemplated for the supply of some hundreds of thousands of lamps. Mr. Ferranti, therefore, undertook to construct his own mains, and, after exhaustive trials, the desired result was obtained in a singularly simple and straightforward manner, by the proper combination of concentric copper conductors, covered with a cheap and

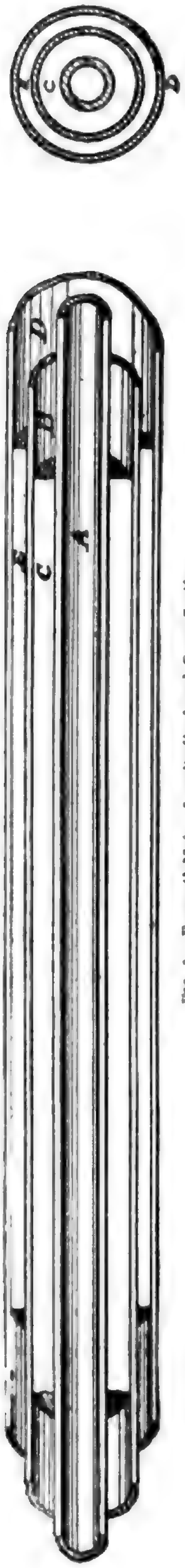


FIG. 1.—Ferranti Main—Longitudinal and Cross Section.

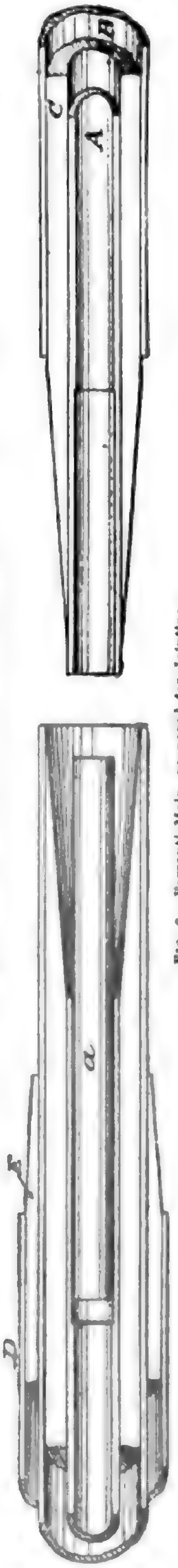


FIG. 2.—Ferranti Main, prepared for Jointing.

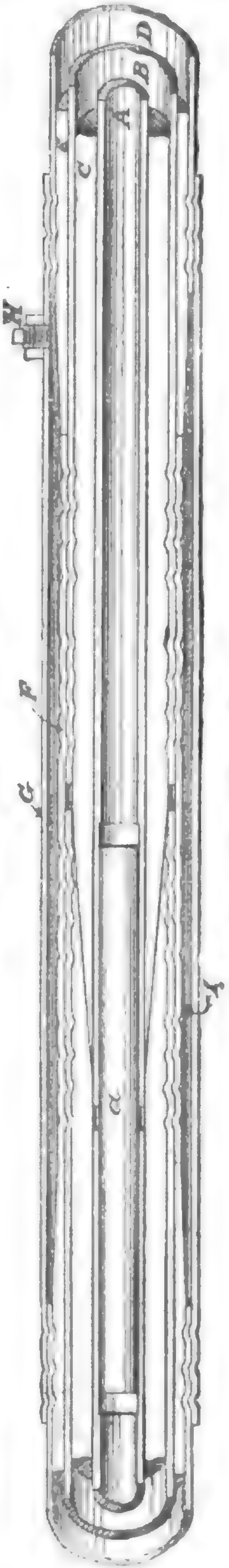


FIG. 3.—Joint of Ferranti Main.

A, Inner Conductor; B, Outer Conductor; C, Inner Insulation; E, Outer Insulation; a, Copper Rod at Joint of Inner Conductor; D, Iron Sheath; G, Iron Sleeve at Joint of D; F, Copper Sleeve at Joint of Outer Conductor; H, Hole and Plug in G for running in Compound to finish Joint.

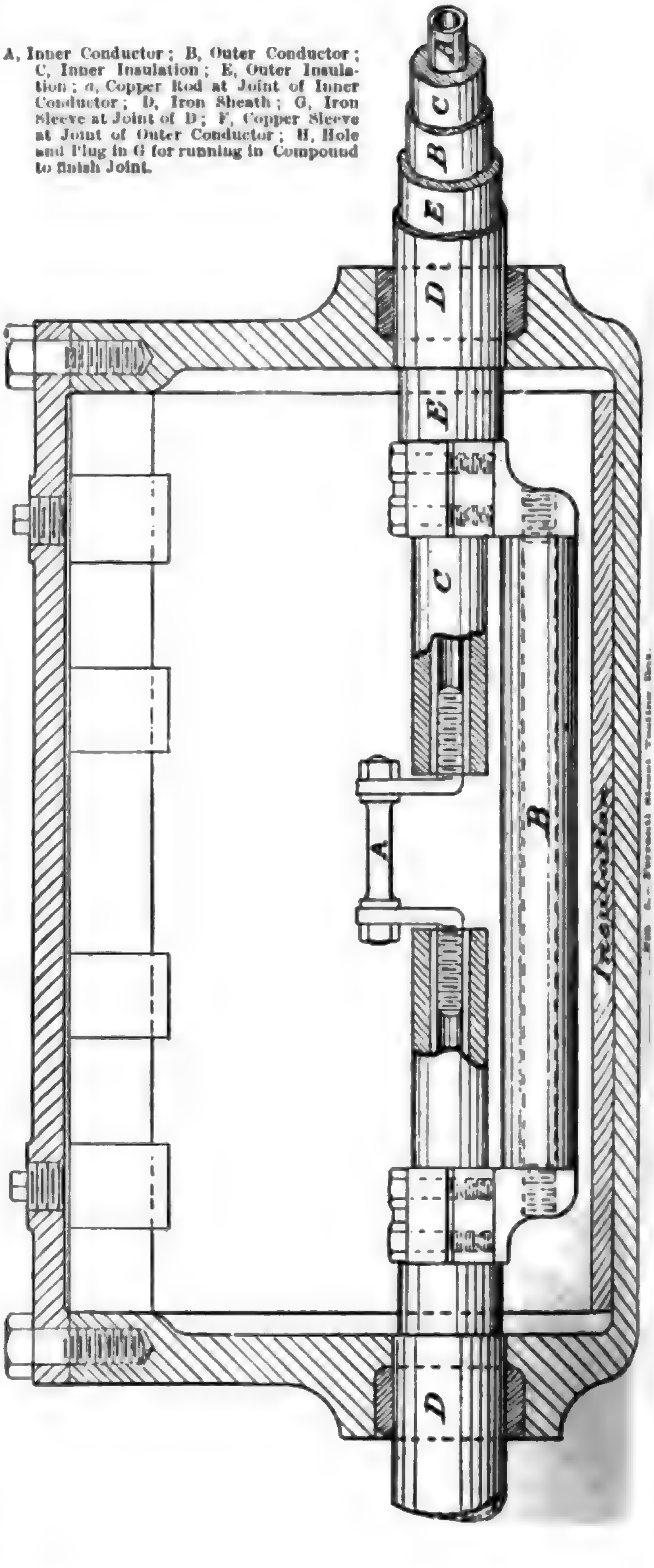


FIG. 4.—Ferranti Street [illegible] Box.

easily-procured insulating material, together with the perfection of a special method of jointing.

The transmission of rapidly-alternating currents having been demonstrated by Sir William Thomson to take place principally along the outer surface of a solid conductor, the core being practically inert, Mr. Ferranti determined upon the use of copper tubes as conductors, to be placed one inside the other, and separated by ¼in. of the most durable insulation that it was possible to find.

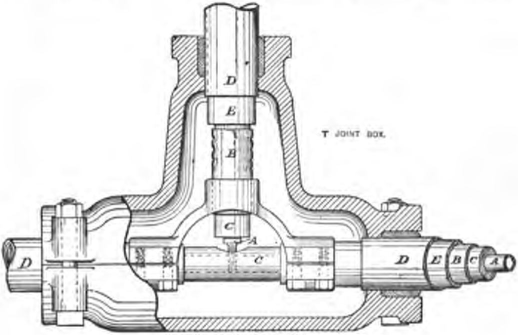


FIG. 4.—Ferranti T Service Junction Box.

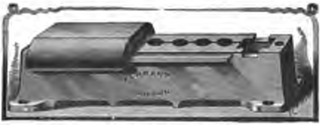


FIG. 5.—Ferranti House Fuse for Primary Circuits of Transformers.

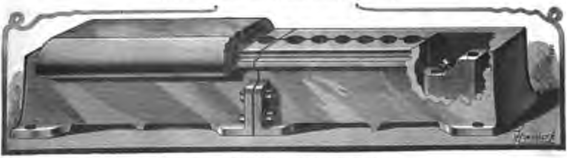


FIG. 6.—Ferranti Main Station Fuse for Multiple Fuse Wire.

The problem of how to secure sufficient insulation, combined with the difficulty of manufacturing and laying heavy concentric mains at this enormous pressure, was one that seemed to offer insuperable difficulties, and when, in addition to this, Mr. Ferranti resolved to manufacture the mains in short lengths of 20ft., necessitating an immense number of joints, scepticism as to the result was rampant, and it is safe to say that no living electrical engineer beside himself would have dared to propose or attempt to carry out such a system. Now, however, that the mains are constructed, laid, and have been working with success since February 15, 1891, the correctness of his ideas seems to be justified, and a most important problem in the practical handling of high-tension alternating currents has received a solution.

It may be interesting to recall, in the first place, that Mr. Ferranti was the first to introduce the distribution on any considerable scale by means of high-tension currents at 2,500 volts, a step which was regarded as an immense jump at a period when any pressure over 100 volts was rare. Having demonstrated that with suitable precautions there was no greater danger resulting from the use of such pressures than with, say, 50lb. of steam in a boiler, the second jump from 2,500 to 10,000 volts, though daring, was in reality by no means as much so as that from 100 to 2,500 volts, for the same precautions, with added insulation, proved sufficient. It is interesting to remember, however, that a pressure of 10,000 volts will give a spark between terminals of ¼in. or so in air, and on a damp day sparks with the sound of a pistol-shot will jump over an inch or more of insulating surface. It was to conduct a large current at this pressure, and to secure permanently good results, that the Ferranti mains had to accomplish.

After many and exhaustive experiments the insulating bodies which were finally selected were paper and black ozokerite, or earth wax. It will be interesting here to give Mr. Ferranti's ideas upon the subject of insulation of high-tension mains, a subject to which he has naturally given more than ordinary attention.

The necessary points to consider are two: durability of substance and the factor of safety. No one can definitely tell how the insulation may change in course of time, but what can be at once tested is the factor of safety of such insulation. No fault will develop in the insulation unless the dielectric is sufficiently strained to produce enough mechanical effect to cause a gradual change; in other words, unless it is strained beyond the limit of elasticity. To take an example in mechanical engineering, a connecting-rod, for instance, the metal may be strained to any point within its limit of elasticity, and nothing gives way; strain it outside this limit and it may go at any time—in a week, a day, an hour, according to the overstrain. Its strength will depend upon the margin of safety. It is the same with insulation. Strained below the limit, the insulation will not give way; strained above its limit, the breakage is but a question of time. The Ferranti mains are made with a very large margin of safety, a margin that has been accurately determined by direct experiment. From these experiments it is found that a thickness of $\frac{1}{16}$in. of paper saturated with the black wax, is pierced within one hour by 20,000 volts—some specimens will go within ten minutes, and nearly all within the hour: above that thickness the insulation is not pierced. This being so, with the present mains, which have ½in. of insulation, there is eight times that thickness, and with half the number of volts we have 16 as the factor of safety. In the Ferranti mains there are 60 layers of waxed paper wrapped one above the other, and the factor of safety is so large, even if one or two layers were partially faulty, it may be trusted to the remainder to give perfect safety. In point of fact, no failures of tested mains have yet been experienced by reason of direct failure of the insulation. Fifteen faults in all were experienced in the 30 miles already laid, mostly of want of continuity. Only two faults were found with 20,000 volts on the whole run, both of these due to water in the joint at the time of making. Mains constructed for only 2,500 volts have been tested for months with 25,000 volts without giving way, and it is on a series of practical experiments such as these that Mr. Ferranti is relying for the safety of his larger mains. There is, we may say, a gradual mechanical change if the insulation is too thin. There is no change at all if the insulation is sufficiently thick. The pressures in the present form of mains have been doubled and trebled, running up to 28,000 volts to try and break down the insulation, but they have been unable to do this, and so feel perfectly happy with their 10,000 volts.

Nothing but time, of course, can prove the question of durability of the insulation, but the materials have been chosen as the most durable it is possible to find. The wax used for insulating is the very same black wax as that in which the mummies were boiled to preserve them in old Egyptian times. The oldest mummy in the British Museum was found wrapped in linen and boiled in this same black wax. The chemically pure paper used is hermetically sealed down from the air by the tube which is drawn tightly over it. Paper, again, is one of the most permanent substances known. There is a papyrus book in existence known to have existed 3,000 years. Two of the most permanent materials in the world have therefore been used in the Ferranti insulation. It is not maintained that these mains will last 3,000 years, or 1,000, but Mr. Ferranti does consider that the chances are so enormously in their favour that they are commercially good enough for our day.

With regard to the jointing, this is a most important part of the whole system. The mains are constructed ready for laying in the ground; the weight is heavy and the length is kept to 20ft., so that a few men can handle them. In the 30 miles of mains there are therefore seven or eight thousand joints. To allow this the joint must be absolutely safe when once properly made. This indeed is what renders the whole scheme practicable. To make such a joint in the insulation was an achievement long doubted, but is now proved perfectly possible. The desiderata were a very long jointing surface and perfect contact. These were achieved by making a long slanting cone-like surface, the protruding point of one main fitting into the hollow of the next, these surfaces being accurately and truly turned and polished to gauge, and then heated and forced together by hydraulic pressure, by which means the insulation becomes practically one solid piece.

Having said so much as to the principle of the Ferranti mains, we will briefly again describe the manufacture for the purpose of completing this series of articles. Tubes of high conductivity copper are taken, cut into 20ft. lengths, and straightened. The usual size of tube to carry up to 250 amperes is of ¼in. section, and the size $\frac{9}{16}$in. inside diameter, and $\frac{13}{16}$in. outside diameter. Lengths, 20ft. long, of brown paper are cut off from a roll 3ft. wide, and a length of this paper is glued by its edge to to the copper tube. Meanwhile, other rolls of paper are passed over long iron plates heated below by open fires, and thus thoroughly dried; these are passed through a bath of hot melted black mineral wax, drawn over rollers and through the air for some distance until dry; they are then cut into 20ft. sheets and placed for use on shelves. The copper tube has squared pieces of wood knocked into its ends, and is then placed in sockets of a slowly-revolving roller on a table which has at the back a set of rollers, a bath of hot wax, and revolving gear. As the tube revolves, lengths of the prepared paper are inserted between it and the brown paper, sheet after sheet, until 60 sheets are served in. During this time heavy rollers come down upon the tube, compressing the paper, and at the same time by displacement boxes dipping into the bath, the wax is made to flow up and saturate the sheets. When the required thickness is served the wax is made to flow back, the insulation compressed still more upon the copper tube, and a tape is wound spirally over the whole. The tube covered with its insulation is then removed, the wooden pieces knocked out, and the whole slipped into a second tube of copper. This tube is of the same total cross-section as the first—viz., ¼in.—but being larger in diameter is proportionately thinner. The size of this tube is $1\frac{27}{32}$in. inner diameter, and $1\frac{15}{16}$in. outer diameter. The tube is left a little larger, so as to slip easily over the inner tube with its insulation, and is then passed through a die and drawn down upon the insulation. This outer tube is now served with the insulation in the same manner as the inner tube: first a length of brown paper glued by one edge, then several sheets of waxed paper to the thickness of ½in., compressed and taped as before. The whole is slipped into an outer iron tube to act as a protecting shield. Melted wax is forced by a pump through a small hole in the centre beneath this iron casing till the inner space is completely filled. The whole is then sawn off at the ends into exact 20ft. lengths. The section of the main is shown in Fig. 1.

The next process is the preparation of the joint. One end of each length is formed into a projecting cone, and the other end into a hollow cone, by means of a special hollow spindle lathe. The length is placed on this lathe, the outer iron shield is removed for a distance of 17in. from the end; 14in. of the outer insulation, E, thus exposed is then turned up, leaving bare that length of the outer copper conductor, B; 6in. of this conductor is now removed, and the insulating material between the two tubes is turned carefully down, forming a cone at the end of the cable, as shown in the illustration, Fig. 2. The interior of the inner tube is then slightly enlarged by drilling for a length of 6in. inside.

The length of main is then reversed, and the insulation, C, of the other end is coned out for a distance of 6in. to exactly the same taper, while the iron shield is removed for a length of 11in., and the outer insulation for a length of 8in., leaving the outer conductor exposed for this length.

The mains are now ready for laying. Each length is separately tested to 20,000 volts, the ends are capped to prevent dirt getting in, and are then sent out to the place required. They are jointed together on the spot, as follows (see Fig. 3): A tight-fitting copper rod, *a*, 12in. long, is driven into the inner tube, A, of the hollow coned end. A tight-fitting sleeve of copper, F, is driven for a distance of 8in. on the outer conductor of the main to which it is to be jointed, and this sleeve firmly gripped on by means of a special tool by three or more circular corrugations, as shown. The two cones are then inserted one within the other, the surfaces being previously warmed, and are forced together and driven home by screw clamps, a total pressure of about three tons being employed, and when still under compression the copper sleeve is firmly locked to the other outer conductor by means of circular corrugations as before described. The sleeve, F, and the outer insulation, E, are wrapped at the junction with insulating material until they become of the same external diameter as the iron tube, D, when an iron sleeve, G, 30in. long, is passed over the joint and corrugated down at both ends. In order to fill up any air space in the outer insulation, hot wax is forced in through the boss, H, of the sleeve, G, the whole being finally closed with a gas plug.

The laying of concentric mains is thus relatively a very simple matter; they are supplied ready for jointing together, and may be carted out and laid as gas-pipes are, no cement channels or specially-prepared conduits being necessary. It is usual, however, in crowded streets to lay them in a wooden trough, with wooden separating slips, the trough being filled in with pitch with an upper layer of concrete for extra protection. They may be laid under any pavement or roadway, causing a minimum of disturbance and occupying a minimum of space. As will be seen, they adapt themselves readily to laying through tunnels and subways, in which case they may rest on wall brackets. When laid in this manner they are subject to variations of temperature, to compensate for which all that is necessary is to give them at certain points a slight wave in laying. To bend a main to go round a corner an ordinary rail bender, as used on railways, is employed; a curve of 6ft. radius being made in this way with but little trouble. In bending, it is found there is no appreciable drag between the layers of insulation and conductors.

For making branch connections a special T-joint is employed; this consists mainly of a cast-iron box with suitably designed base and cover arranged to fit watertight. These joints do not, of course, appear on the road surface, being inserted in the run of the mains as required. The joint has three stuffing-boxes through which the ends of the mains are brought in. A screw bolt from the centre of the branch main connects to the inner conductor of the main itself, and the joint is wrapped with paper insulation; the outer conductors are connected with a gunmetal bridge-piece of the shape shown, Fig. 4. Street boxes are also placed in the run of the mains at distances of about 200 yards. These are iron boxes similar in principle to the T-joint boxes, but are placed in small brick chambers, having removable covers flush with the road surface, Fig. 5. The interior is thus accessible for testing and other purposes, while the arrangement of the connections is such that the joint can be easily and quickly connected or disconnected. These joint and street boxes may be filled with rosin oil, by means of which very high insulation is insured at these points, and the full pressure of 10,000 volts may be safely used. While the above description applies more particularly to mains for parallel distribution, the system may be employed with equal advantage for series work.

With regard to the resistance of long lengths of these mains, a length of 7½ miles (*i.e.*, 15 miles of lead and return) between London and Deptford was tested by Dr. Fleming, and the actual resistance was found to be 2·20 ohms, while the calculated resistance of a length of copper of that section was 2·16 ohms, thus showing that the resistance of joints is inappreciable. The mains can be touched on the outside and handled with impunity when a current at the highest voltage is flowing, without the possibility of anyone receiving a shock, the metal covering being to earth and acting as a complete discharge shield. In the event of a fault occurring between the inner and outer conductors, the current can only return direct to the machine, where the safety fuses prevent it doing any harm. The fuses employed are also illustrated herewith. The smaller one, Fig. 6, has a 12in. break, and is used in houses for the primary circuits of transformers. The larger fuse, Fig. 7, is identical with the first, except that it is adapted for main currents, and has a multiple fuse with a 24in. break. The plugs are arranged for separating the multiple fuse wires.

The absence of necessity for channels or conduits in the Ferranti system is an item which should be taken into account, and has, further, the immense advantage of avoiding the possibility of explosions from an accumulation of sewer or lighting gas, which have occurred so frequently with both high and low tension systems throughout Europe and America. Explosions of this kind have already occurred in London. In fact, when a conduit or line of pipes is opened, the presence of gas (which is found, moreover, to impair the insulation of cables laid in that manner) is very frequently detected. Such methods are also liable, sooner or later, to dangers which arise when water is present. For instance, when bare conductors are used and water gets access to them, they are liable to be short-circuited or injured by electrolysis. With insulated cables in pipes or conduits, the alternate presence and absence of water affects the insulation, damaging it in time, and when it is present in winter, it is liable to freeze—the ice crushing or piercing the insulation and causing partial or total short-circuitings. This occurred in London during the late winter of 1890-91.

With regard to safety the following experiments were carried out:

In the presence of representatives of the Board of Trade, the Post Office, and local authorities, a main which had been running continuously under a pressure of 10,000 volts was submitted to two engineers, who, with a cold chisel and sledge-hammer, managed, after considerable time and much deliberate labour, to cut through from the outer to the inner conductor while 200 h.p. at that tension was being transmitted through it. They did not feel the slightest shock, although they were standing on a large metal plate making earth. A similar trial has been made with a pickaxe. The mains have also been submitted to a lengthened test, after laying, with 30,000 volts, and have given no trouble. It has thus been forcibly demonstrated that this system of conductors offers every possible guarantee of human safety.

We have referred to the Ferranti mains more particularly, perhaps, in connection with high-tension distribution, but it is apparent that they are also adapted for 100-volt or other low-tension distribution, or where a large mass of copper is required. By their construction the greatest amount of copper conductor is contained in the least space, the cables are buried direct without the use of conduits, and can be carried anywhere and under pavements where there is no room for conduits. The house connections are rapidly and cheaply made, perfect insulation is obtained, there is no fear of any short-circuiting from water, and no fear of explosions. For three-wire distribution the cable is manufactured with three concentric conductors instead of two, and is laid and jointed exactly as above described. We understand that arrangements are now made by Messrs. S. Z. de Ferranti and Co. with a large firm in the North of England for the manufacture of the Ferranti mains on a considerable scale, and large plant is being put down for this purpose.

MAJOR BAGNOLD'S PATENT IMPROVED BELL-PULLS AND BELL-REPEATERS.

For over 40 years the familiar push-button used in conjunction with electric bells has remained unaltered except as regards the artistic design of its exterior, notwithstanding that considerable inconveniences are connected with the use of this simple household fitment. The ordinary push-button must be pressed in a direction at right angles to the surface of the wall or other support to which it is fixed. Again, the contact made is not always of the best;

it is essentially a "butt" contact, and possesses little or no self-cleaning powers. When definitely established, say, in the immediate neighbourhood of a bed, or of an office, or dinner-table, it is difficult to actuate these push-pieces from any other position. Pull-pieces have been devised, but these need to be pulled, as a rule, in one particular direction; flexible cord connections are also used, connected to "pear" pushes, but these again are seriously liable to derangement, and may be said to contain the elements of their own destruction. Generally speaking, there are many instances of daily occurrence in which the shifting of a bed, of an invalid's chair, or of a writing-table necessitates the advent of the electric bell-hanger and the moving of the contact-piece from one position in the room to another. In order to obviate these inconveniences, Messrs. Siemens Bros. and Co. are now supplying, under license from Major Bagnold, a simple and effective arrangement of bell-pull which, no matter where fixed in a room, can be easily actuated from any point in that room by attaching a thin cord, and leading this cord away in the desired direction; a very slight pull on the cord is necessary to make contact and ring the bell. A diagram of the bell-pull and connections is shown in Fig. 1. An elastic rod of steel, R R, is set vertically with its lower end firmly fixed into a brass block, B; on its upper end is screwed a brass knob, K, the shank of which passes through a brass ring, C C; the conducting wires are attached to B and C. A slight pressure applied to K in almost any direction other than in that of the axis of the rod, R R, will deflect that rod, and cause the shank of the knob to touch the ring, C C, and make the necessary contact. This contact needs no silvering or platinising, as the knob can at any time be given a circular motion, which will clean the contact surfaces and ensure the establishment of the circuit. If it be desired to actuate this contact-piece from a distance, it is only necessary to tie a fine cord round the horizontal groove on knob, K, and this cord can be led off in any required direction such as to a bed, a chair, or a dinner-table.

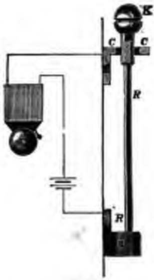


FIG. 1.

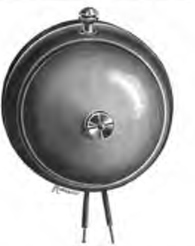


FIG. 3.

This bell-pull, which is also shown in Fig. 2, is made in various patterns and sizes. It can also be conveniently combined with a sound repeater. When a bell-pull or push is actuated, it is of immense convenience to be able to know that the electric bell has rung. Figs. 3 and 4 show a new form of sound-repeater, which, combined with the contact previously described, makes a most convenient and efficient fitting for this purpose. In Fig. 3 the repeater is shown complete with the nickelled steel bell dome, and in Fig. 4 without the dome. When the latter is screwed on, one pole of the electromagnet is presented to the sound-boss of the bell; as soon as the contact is closed and the circuit is intermittently interrupted at the distant "chattering" bell the bell dome of the repeater is set into vibration, and gives out a clear ringing sound sufficient to indicate that the distant bell has acted, but not so loud to be inconvenient to the occupants of the room in which the contact is made.

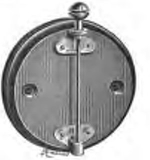


FIG. 2.

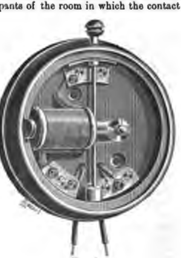


FIG. 4.

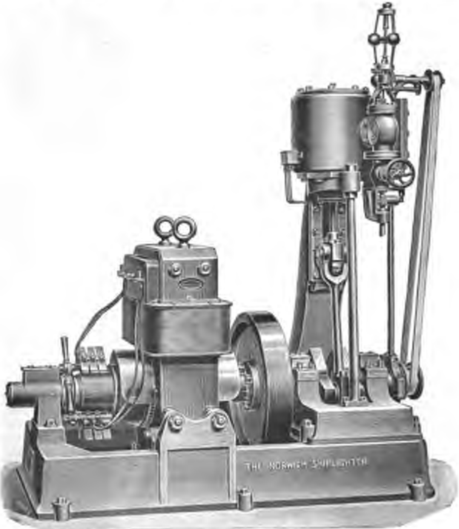
The above-described system of ringing a steel bell magnetically can be applied in other ways. Thus, supposing it is desired to actuate several bells in series on one circuit, one of these can be an ordinary "chattering" bell and the others can be simply "sound-repeaters" without contacts. No difficulty of adjustment is experienced as in the case when ordinary chattering-bells are joined in series.

The special bell-pull and the repeater-bell are fully protected by patent, and Messrs. Siemens Bros. have been appointed sole manufacturers of the apparatus.

SHIPLIGHTING PLANT.

The accompanying illustration represents one of Messrs. Laurence, Scott, and Co.'s shiplighting plants, SL5 type. The output of the one illustrated is 65 volts, 140 amperes, at 260 revolutions per minute. The engine is well and substantially built, with very large bearing surfaces and ample lubricating arrangements, but otherwise calls for no special mention.

The weight of the dynamo field magnets is taken through brass packing-pieces on two strong ribs that run across from one side to the other of the bed-plate, whilst they are held in position by means of the muntz metal studs coming through the strong brackets on the side of the bed-plate, circular brass distance-pieces being arranged between these brackets and the magnet poles. A very rigid job is thus secured. The armature of the dynamo is of Laurence, Scott, and Co.'s usual type, the conductor being wound in slots milled into the plates which form the armature core. These plates have hexagon holes, into which the hexagon steel shaft is driven with insulating-pieces, so that the mechanical arrangement is exceedingly good, and the armature will stand an amount of rough usage and hard work that would be fatal to any other kind. It is absolutely necessary, if an armature of this kind is to be successful, that the opening between the projections and the periphery of the armature—*i.e.*, practically the width of the slot—should not exceed a certain amount. In practice, it is found it should not be more than twice the clearance between the armature and the pole-pieces. In the commutator of the above machine there are 110 sections, one turn of conductor to each section; but there are only 55 slots cut in the armature, each ·355in. wide. This would be an excessive width, but in winding, each slot is made into two by means of three longitudinal strips of charcoal iron, running the whole depth and length of the slot, but insulated from both the conductor and the armature core. These strips reduce the width of each slot to ·14in., and thus make the outside surface of the armature sufficiently even, magnetically, to entirely do away with the heating of the pole-pieces and noise that would have been caused by the wider slots. The armature of the machine is 13⅛in. diameter outside, 11⅛in. at the bottom of the slot, and 9in. long. It is wound with four parallels of No. 13 wire braided. The magnets call for no special mention. They are of Lowmoor iron, and have a sectional area of 85 square inches. The ampere-turns in the shunt are 9,370, and in the series 7,840.



The plant illustrated was worked up to 200 amperes for six hours before leaving the maker's works. Even with this very excessive load there was no sparking, and the rise of temperature in the armature at the end of the test was only 80deg. F. The makers have recently obtained a license from Mr. Gisbert Kapp to use his patent end connections for strip armatures, and these will be used in all the large machines. They have been making a large number of shiplighters for Scotland and the North of England during the last 18 months. They have had an absolutely clean record with them, not a single breakdown having occurred up to date, and the buyers in every case have been thoroughly satisfied.

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ELECTRIC TRAMWAYS.

It is instructive, if not amusing, to notice the criticisms against any new departure. The great majority of those who write seem to imagine that the end of all writing is faultfinding. A few writers indeed find a reason for such faultfinding. They contend that success is more likely to come if all faults are diligently sought out, in order that they may be remedied. No doubt there is something in such argument, but it is worth very little. The person who is doing the work knows more about the weak points than any casual critic can tell him, and usually knows also of weaker points which are more or less unknown to the critic. The introduction of railways was strenuously opposed, as was the introduction of gas, and as is the introduction of electric light and traction. A good deal has been said against overhead wires for tramlines. Surely the better plan is not to censure indiscriminately, but to assist even the introduction of overhead lines in convenient places, so that we may acquire a practical knowledge of the disadvantages and of the advantages of such systems. Discussing quite recently the question of the fundamental financial knowledge required for the quicker development of electric tramways, Mr. Graff Baker contended that what all wanted was the actual working expenses free from what he termed general charges. The receipts of a tramway company are split up into three parts—one portion has to pay the working expenses, a second has to meet the general charges, the third, or the balance, being profit, goes in dividends. We understand that in America the interest upon debentures is generally charged to working expenses, while in England it is usually the first charge upon profits. Of these three parts the first, or the working expenses, of any one system is pretty constant, the other two can in a paying concern be made to fluctuate considerably at the will of the directors. The item that fluctuates most in the working expenses is perhaps the coal bill. Thus, while the wages of car driver and conductor, of engineer, electrician, stoker, and labourer are pretty much the same at Leeds or Exeter, the cost of coal is not so constant. It is only from actual experience that the actual cost of working a tram per car mile run can be known. Unfortunately, the peculiar methods used in making balance-sheets of public companies usually prevents any decisive answer being given as to "cost per car mile run," otherwise in the course of a few months we should have here in England a sufficient knowledge of the subject to determine the problem. In order to see which is the best system, however, we must know more. Consider for a moment the three systems at present before us—(1) with overhead wires; (2) with batteries; (3) with underground conduits. The cost per car mile run on each of these three systems must be very different for them to be equally commercially successful. It is pretty certain that the initial or capital expenditure upon the first system would be least, and it is difficult to see how the working expenses could be higher than in either of the other systems, hence undoubtedly number one would be commercially more successful than either of the others. It is important, therefore, to know the cost of construction per mile. In another column we give a paper read at the recent Street Railway Convention at Pittsburgh. The various money columns are in the American currency, but it will be easy for those who are discussing tramway work in England to translate the various amounts into English currency. Given that the conditions in America are greatly different from those ruling here, we contend that this is the kind of analytic statement it is desired to obtain from English practice in order to be able to fully understand the possibilities of electric traction. Figures of this kind form an admirable argument in reply to the "bird-in-the-hand" theory we referred to last week. We agree, then, so far, with the contention of Mr. Graff Baker, that an accurate knowledge of the working expenses should form the best lever to induce capitalists to find the capital necessary for the change. At some future time it may be necessary to discuss the question of general charges, but in the meantime we ask those who have charge of electric tramways whether they cannot, without disadvantage to the concerns which they control, from time to time publish authoritative analyses of working expenses for the benefit of those who are still watching and waiting.

CANTERBURY.

A protracted discussion took place at the Canterbury Town Council last week upon the electric lighting question. The Electric Lighting Committee reported that, having consulted with the Brush Electrical Engineering Company, they recommended that the Canterbury electric lighting order be transferred to that company on the following terms: That the company pay costs of obtaining the order, to be not over £350; that the Corporation have the right to take over the works at the end of twenty-one or thirty-one years as a going concern, including a valuation for goodwill; that no other order be granted within the borough; and that the agreement be subject to the formation of a local company, with a nominal capital of £50,000, to which the proposed agreement be transferred, the Brush Company paying all costs of such transfer. These were the heads of the agreement. Alderman Mount, as chairman of the Council, moved the confirmation of the report. He considered they had made very good terms with the company, and did not think it necessary to call in other experts. The company would have to compete with the gas, and would in their own interest supply it at as low a price as possible. Alderman Hart, one of the directors of the gas company, mentioned that he was a party a little while ago to an application for power to supply electric light themselves; but the Local Government Board returned an answer that they did not allow any gas company throughout England to have this power, because it was desired to place it in the hands of the councils. Having the power granted to them, he thought the Council should reap the profit and not the company. The water supply he instanced as necessitating 200 or 300 per cent. advance in price from that demanded years ago, and asked the Council to go into committee and consider the agreement clause by clause. Alderman Mount said that they had given the matter careful consideration, and had selected the Brush Company as the best. Mr. Mills also thought the arrangement was most satisfactory, and would be sorry to see the Council provide electricity themselves — according to the present business habits they might be bankrupt in three years. It was further stated that the cost of lighting Canterbury would be £2,700 against £1,600, the present cost of gas; but it did not appear that any binding clause was included for public supply, nor to deal with the continuance if the company were not a success. Eventually it was decided that the terms for public lighting should be arranged, and that a draft agreement should be asked for, a copy to be supplied to each member of the Council, and that in a fortnight a committee meeting of the whole Council be held to settle the matter.

CORRESPONDENCE.

,, One man's word is no man's word
Justice needs that both be heard.'

ALTERNATING-CURRENT ELECTRIC RAILWAYS.

SIR,—I read the short note on the above in a recent issue of your paper with much of that gratified chagrin which one feels on finding that another is on the track of one's pet idea. For some time past I have been of settled opinion that direct-current systems are practically out of the field of commercial application for all tramway and open roadway work unless overhead conductors can be employed. The immense, and in fact unsurmountable difficulty of securing any real insulation to a long length of conductor lying continuously or intermittently bare in an open conduit, or to the surface contacts of closed-conduit systems, burdens all such schemes with a fatal and fundamental drawback. And though the objections against overhead conductors are perhaps more prejudiced than real, the feeling against them in this country is apparently too strong to permit of their general adoption here; so that for electric traction in our streets, leaving out of the consideration the too expensive and bulky accumulators, we are forced to the least favourable expedient, so long as we confine ourselves to the use of direct currents.

But once conceive the use of alternating currents for this purpose, and it is surprising how simple the problem apparently becomes. I say apparently advisedly, because it has yet to be seen what purely practical difficulties may arise. Yet being well rid of the two great bogies of bare and practically uninsulatable cables or surface contacts and mechanical collection, a pleasing variety of solutions offer themselves, and true varieties, not mere vagaries and plagiarisms of the same thing. To mention a few we have, besides the method of simple induction from primary in the roadway to secondary on the car, a scheme based upon the repulsion motor principle of Elihu Thomson, and another upon the principle of continually rotating or progressive magnetic fields which are attracting so much attention just now. In both these latter the motor system on the car becomes rather a simple affair, and it goes without saying that the track, on its purely mechanical side, is simple and straightforward enough.

One can indeed anticipate that the more serious difficulties will be found to reside in the moot questions whether the induction or magnetic forces can be concentrated sufficiently upon the "inducted" system of the cars, and whether the heat-losses in the continuous line of iron shell can be kept within commercial limits of efficiency. I am not prepared to take up any definite position on these two points, and it would not be just to myself so far to disclose my own views and schemes; but, in conclusion, I cannot help expressing my confident opinion that in some alternating-current system the best, or at any rate least objectionable, solution of this vexed problem of electric traction on open roads will be found, and those who can carry through the practical pioneering will reap all the honours that in this direction be awaiting the electrical engineer.

Since writing the above I have made a hurried search over recent patents, and I find that Mr. W. Dewey has been working, or at least patenting, in this connection. However, being American, he has not apparently perceived what awful bugbears open slots and mechanical contacts are, and therefore he retains them both in his schemes.—Yours, etc., J. WHITCHER.

October 31, 1891.

THE ROUNDHAY ELECTRIC TRAMWAY, LEEDS.

As our readers are aware, the Roundhay Electric Tramway was officially opened last week. The immediate incidents connected with the opening of this line ought to be chronicled, and as, with the exception of the officials and men engaged upon the line, the present writer alone can speak from his own experience, he will endeavour to tell the history of the last hour or two before the actual running of the cars. The Roundhay Electric Tramway is not finished—it was less complete at the opening ceremony. Imagine a careful estimate of time for work made by men who know their business, with a safe margin allowed for eventualities. Invitations are issued upon this estimate without a shadow of a doubt as to being ready. But the English weather, as soon as a definite time was fixed, commenced to play pranks. It did not rain—"it poured cats and dogs," as the locals have it—and though waterproofs were bought and provided, the workmen fairly turned tail at the elements. When possible, work was carried out night and day, but still the morning of Thursday, Oct. 29, came, and the work was far from finished. The men had been working all night—they threw all their energies into the task, under the immediate supervision of Messrs. Winslow and Carey, assisted by Mr. Guy. The line consists first of the main from Sheepscar to Roundhay Park, and a branch joining this at the bottom of Harehills-road to the bottom of Beckett-street. This branch was termed the new road, and that was finished sufficient to run cars on the Wednesday before. A single line of trolley wire was run from Sheepscar to Roundhay Park, but only finished on Thursday morning between 12 and 1 o'clock, at which time the connection between the branch and the main line was still incomplete. Men had been labouring all the morning at this curve, but it was not till about two o'clock, or an hour after the advertised opening, that the last joint was soldered, and within five minutes of the time the last joint was made the cars were run from the shed to the line. Here, then, we had a most important work, upon the success of which many eyes turned and more work depended, absolutely untried and untested prior to the official ceremony. We may view this in two ways, and we prefer to look upon it as one of the greatest proofs ever offered to the success of electric traction. In reality the engineers may be taken to have said, "We know our system; we know how the work is done under our direct supervision, and though it is to be officially tried the moment of completion, we fear not the result." This amount of confidence is commendable, but it is somewhat risky. However, in this instance there was no help except to postpone the opening, which was not thought of for a moment. The whole of the cars were placed upon the line, and at once successfully run down the branch to the junction, and thence down the main line to Sheepscar. Many of the invited guests started in the cars from the station, others awaited their advent at Sheepscar. The journey from Sheepscar to Roundhay Park was then commenced, and, with the exception of a wait through the heating of the engine, passed off satisfactorily. In fact, from first to last there was no hitch in the electrical apparatus, and the greatest credit is due to all who have been engaged in the work that it should have been so. A bad joint, a wrong connection—minor faults which are expected and which are usually found and remedied in the preliminary tests—were totally absent. Let us, therefore, in future recollect what the Thomson-Houston people can do with overhead conductors. We saw the line incomplete at Roundhay and at the junction, two hours before the cars were successfully running. Greater praise than this statement cannot be given to Mr. Winslow and Mr. Carey, upon whom rested the responsibility of having the line ready for the opening ceremony.

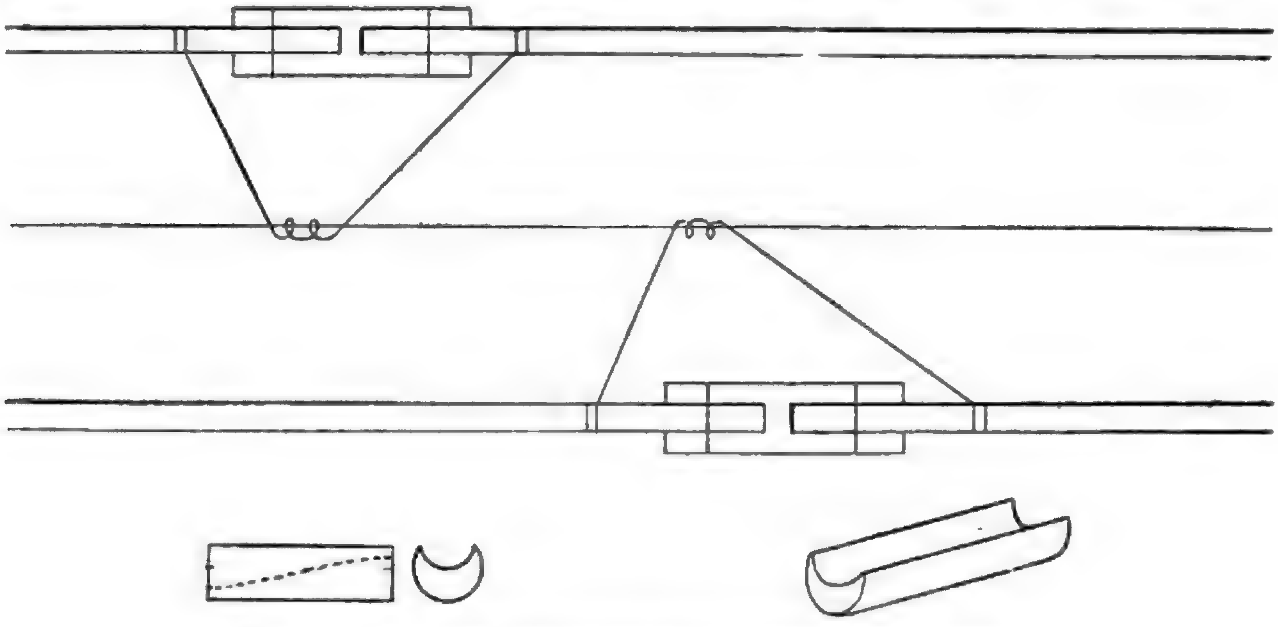

FIG. 1.—Plan of Rails Showing Connections (Thomson-Houston System).

The Roundhay tramway line consists partly of single and partly of double track. The track was laid ready to the hand of the electric company, so that their work in connection with the roadway has been to adapt a track laid for horse or steam traction to the requirements of electric traction. The metals and road-bed of the entire lines have been laid in the very best style of tramway construction, comprising grooved girder steel rails of a section of 98lb. to the yard, laid upon a solid bed of concrete, 18ft. wide and 9in. deep, and tied together at short intervals by metal tie-bars. The joints are laid on sole-plates, and the channels of the rails filled in with cement. The paving of granite setts is placed upon a bed of sand over the concrete, and the interstices between the sets thoroughly pitched. For the purpose of return a central wire of soft drawn copper wire, No. 0 B.W.G. ·34in., Fig. 1, has been laid throughout the system, each tramrail being electrically connected to this return wire and its neighbouring rail, as shown.

The connecting wire, No. 7 B.W.G. soft-drawn copper, is brought into contact with the rails by means of the scoop-shape wedge shown. When these connections were made, so far as the roadway is concerned, the work was finished. For readers whose familiarity with electrical matters is small, we may treat the matter somewhat elementarily and somewhat fully. Briefly, the aim of the engineer is to get a complete metallic circuit. At one point of the circuit, G, Fig. 2, the current is generated by the dynamo. The current, as shown by the diagram, passes along the wire in the direction shown by the arrow to the trolley wire, C. From the trolley wire, C, it passes by the trolley, T, and the conducting wires, shown by dotted lines, in the car to the motors, M M; from the motors through the rails, J, and connecting wires to the central wire, which completes the circuit, back to the dynamo. The electrical engineer can so arrange his apparatus that more than one car can be, so to speak, fed by the same trolley wire. In fact at Leeds, on Thursday week, there were six cars one behind the other, each being fed by the trolley wire, which is of hard-drawn copper, No. 0 B.W.G., or 340 mils diameter.

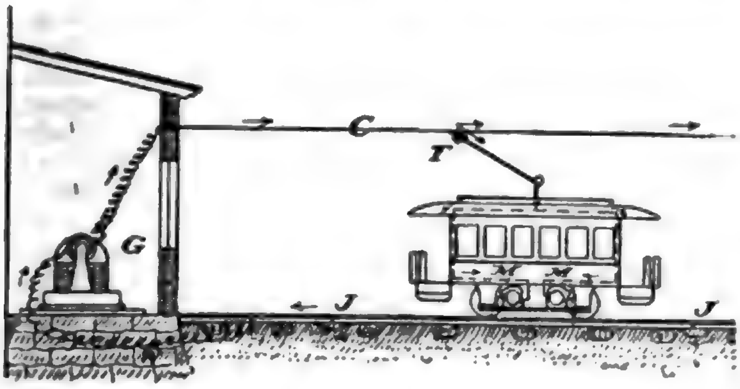

Fig. 2.—Diagram of Working of Electric Tramway.

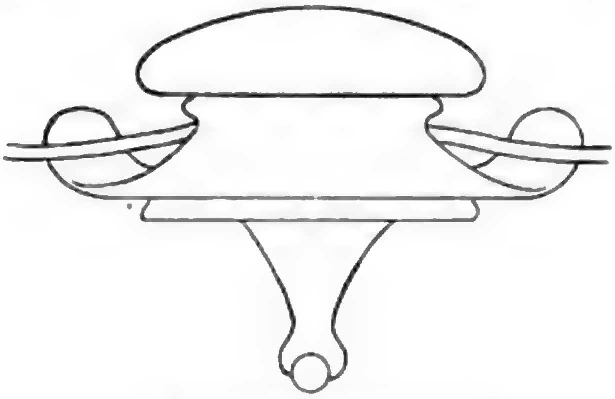

Fig. 5.—Trolley Wire Suspension.

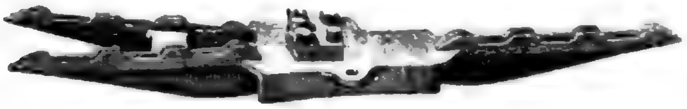

Fig. 7.—Diamond Point Frog.

In actual practice the arrangement is not quite so simple as is shown in the diagram. The trolley wire has to be supported above the centre line of the car, and not only has to be supported, but so supported that there is minimum leakage of current and minimum motion through change of temperature. At intervals of about 125ft., iron standards, Fig. 3, 21½ft. high, 6in. diameter at the base, and 4in. diameter at the top, have been erected. The tops of opposite standards carry the span wires. Fig. 4 shows in detail the top of each standard. The standard itself is hollow. A is a hard wood cylinder soaked in insulating material, and to this insulator the span wire is fixed. Just over the centre of the track is the trolley wire carrier, which in one form appears as in Fig. 5. This carrier is made in several parts, such as screw cap, cone, insulator-holder, etc., some forms of which are shown in Fig. 6. In order to turn the trolley to the proper branch or siding, frogs of various patterns are used, of which Figs. 7 and 8 illustrate two forms. It will of course be easily understood that the arms can be put at any angle, and arranged for right or left hand turnouts. Fig. 7 is a standard form, Fig. 8 is an adjustable crossing.

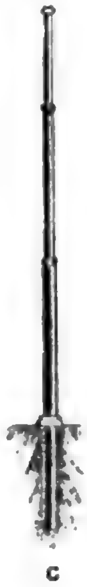

Fig. 3.—Pole.

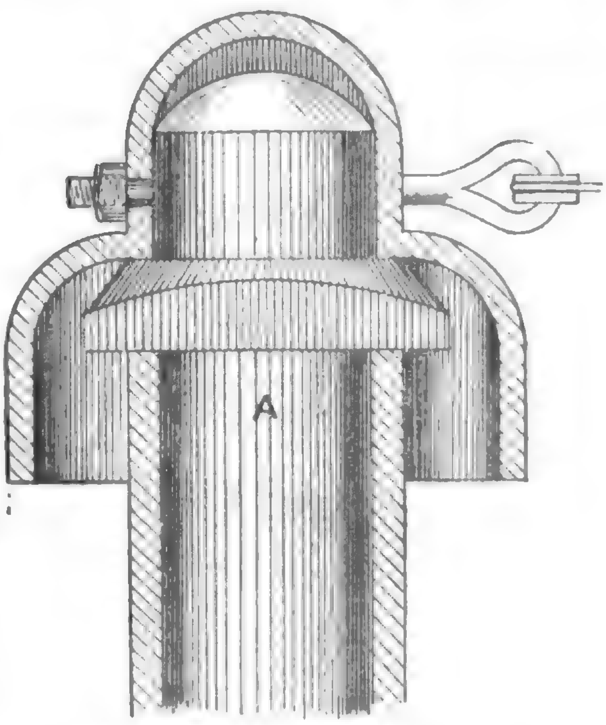

Fig. 4.—Section of Top of Pole.

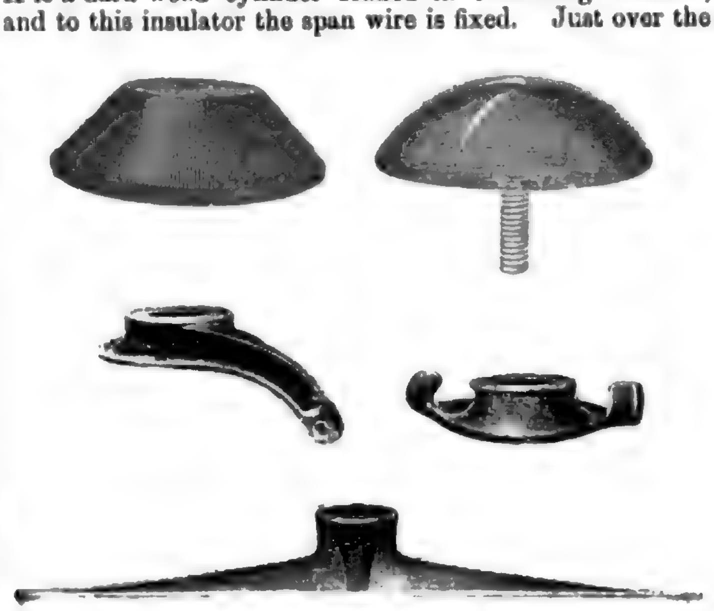

Fig. 6.—Parts of Trolley Wire Suspension.

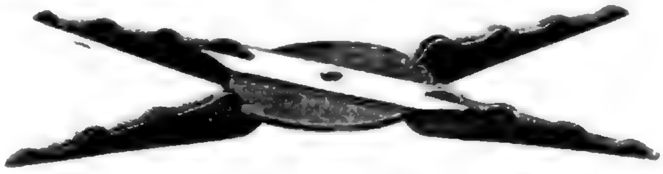

Fig. 8.—Adjustable Crossing.

The mechanism of the trolley stand is shown in Fig. 9.

The diagram, Fig. 2, shows it fixed to the top of the car. By means of a rope the conductor can lower the trolley, otherwise the action of the springs is to keep the wheel in contact with the trolley wire. The head of the trolley bar is shown in Fig. 9. The height of the trolley wire determines the length of the bar. At Leeds the trolley wire would be about 20ft. above the road, and, we imagine, some 10ft. above the top of the car. The right-hand standards near the top carry cross-pieces upon which are insulators carrying the feeding wires. In the Leeds installation there are two such feeding wires—the one 0000 B.W.G., the other 00 B.W.G., with Simplex insulation. A good part of the wire used has been supplied by Messrs. W. Glover and Co., of Manchester. The following information about these sizes of wires may be useful :

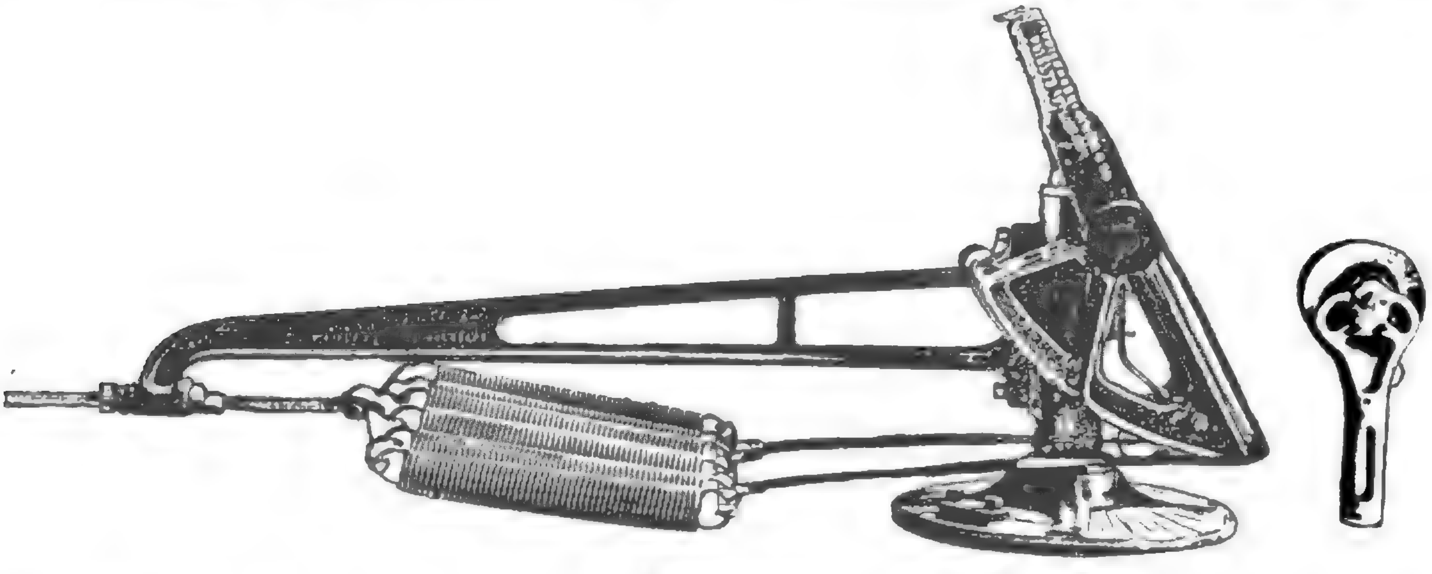

Fig. 9.—Trolley Stand.

Gauge No.	Size.		Weight and length.			Resistance.		Carrying capacity 2,000 amperes per square inch section.
	Diameter in mils.	In circular mils.	Grammes per foot.	Pounds per 1,000ft.	Feet per lb.	Ohms per 1,000ft.	Feet per ohms.	
								Amperes.
0000	460	211600	4477·2	639·6	1·56	·051	19929·7	430
00	364·8	133079	2815·8	402 2	2·48	·080	12534·2	208

We ought to have said that the spanning wire is of steel, No. 5 B.W.G., and has a tensile strength of 60 tons per square inch.

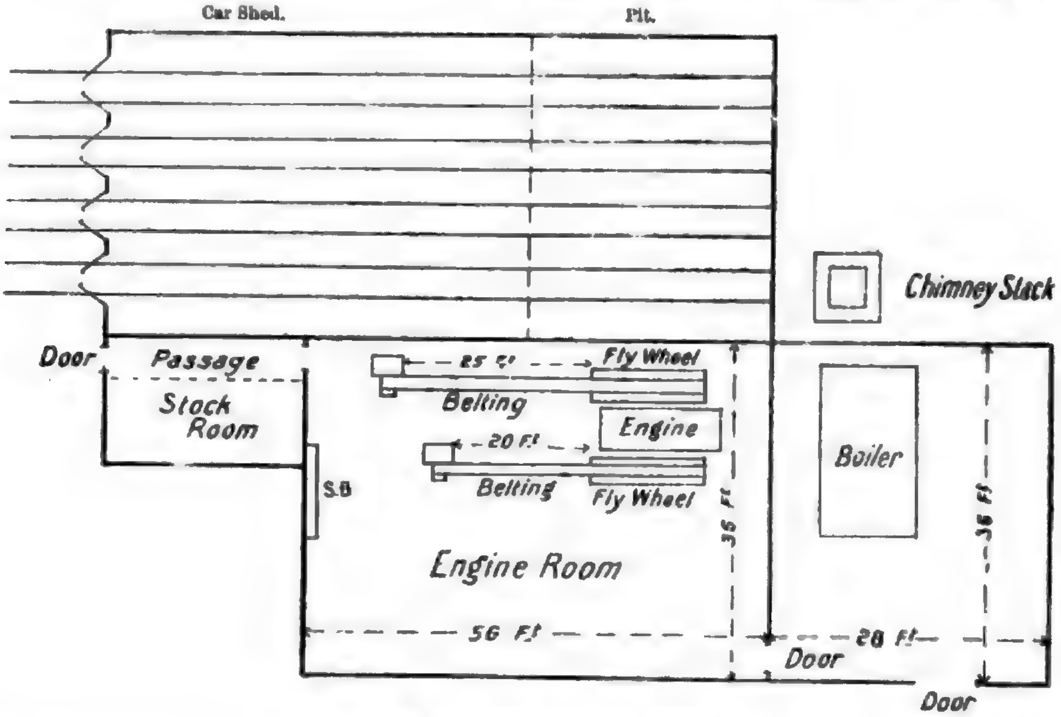

Fig. 10.—Sketch Plan of Station.

The total length of tramway operated electrically is about 5½ miles, comprising about two miles of double line on the Roundhay-road, containing grades of 1 in 20 for a distance of a quarter of a mile, and 1 in 21 for a similar distance. The single line has several passing-places, and contains a gradient of 1 in 28 for three quarters of a mile.

We now come to the central station, which is just off the junction of Harehills-road and Beckett-street. Fig. 10 gives a sketch plan of the buildings, of which the car-shed has been built from the designs of Mr. Hewson, the borough engineer. As will be seen, the car-shed is on the side of the dynamo and engine room.

It is substantially built of brick, and roomy enough to stable 12 cars. At the far end of the shed is the pit, 30ft. by 40ft., the rails running on piers so as to enable the workmen to get underneath the cars for repairs or cleaning. The remaining part of the building is more temporary in character, being built of corrugated iron. The boiler-room, 38ft. by 26ft., contains a Babcock-Wilcox 192-h.p. boiler, fitted with feed-water heater and Bennis mechanical stoker. There is sufficient space to duplicate the present boiler if necessary. A brick partition parts the boiler and engine room. The engine is a McIntosh and Seymour single-cylinder (18½ by 18in.) built at Auburn, in the States, and runs at 200 revolutions per minute. This engine drives by belting, as shown in Fig. 10, two Thomson-Houston 80-h.p. motor type dynamos, shown in Fig. 11, each giving 300 volts at 900 revolutions per minute. The current from the dynamos, which run in parallel, is led to the switchboard, S B, Fig. 10. This switchboard is excellently designed and fitted, and worth illustrating, but though we hope to do so in the future we are unable to illustrate it in the present article. It is fitted with two Thomson-Houston current indicators, two automatic circuit breakers, a voltmeter, and the necessary switches, resistances, etc. The normal current of the dynamos is 215 amperes each.

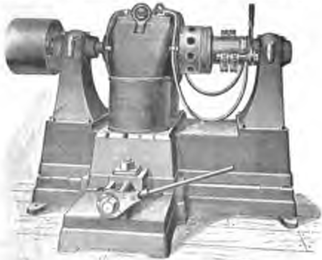

Fig. 11.—Thomson-Houston Generator (80 h.p.).

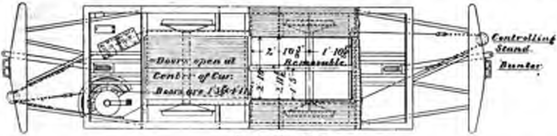

Fig. 12.—Plan of Car.

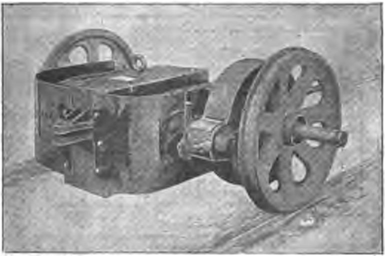

Fig. 13.—Thomson-Houston Tramway Motor.

The cars were built by John Stephenson and Co., of New York, and are very pretty examples of the carbuilder's art. They are fitted for inside passengers only. Fig. 12 shows a plan of the car. Each car is fitted with two single-reduction Thomson-Houston motors, Fig. 13, of 15 h.p. each, geared to either axle, working in parallel, and giving a total of 30 effective horse-power to each car. The motors are noiseless, and the gears run in oil. Fig. 14 shows the controlling and reversing apparatus. At the left we have the controlling stand, worked by the driver actuating the resistances and reversing switch shown. The body of the car is handsomely decorated and upholstered. It is lighted from above by a circle of incandescent lamps, these, of course, being fed through the trolley contacts.

Perhaps after this description of the apparatus, we ought to say something more of the opening ceremony and the invitation dinner therewith. It was unfortunate that Mr. Graff Baker, to whose energy this installation is due was prevented by indisposition from being present at the Town Hall. He would have found, however, that the whole assembled company—with, perhaps, a single exception—were favourably impressed with the installation, and predicted success so far as running is concerned. The commercial success depends upon the traffic, which at certain seasons will undoubtedly be very heavy. However we trust that the successful running will induce the Leeds authorities to permit the extension from Chapeltown-road to some point in or near Briggate. The interest taken in tramway work will be understood by reading a few of the names of gentlemen present at the dinner which was held in the Victoria Hall of the Town Hall, under the presidency of the Mayor, Mr. Alf. Cooke. Among the guests present were Colonel Church, the Mayor of Huddersfield (Alderman Godfrey Sykes), Alderman S. Feather (ex-Mayor of Bradford), Mr. W. J. Carruthers Wain, C.E., president of the Tramways Institute; Mr. J. Barber Glen, secretary London Street Tramways; Mr. J. S. Comrie, director of the Provincial Tramways Company; Mr. J. G. B. Elliot, secretary of the Tramways Institute; Mr. W. Busby, director of the Liverpool Tramways; Mr. G. P. Bradford, director of the North Staffordshire Tramways Company; Mr. G. Waller, C.E., London; Mr. H. E. Whytehead, manager North Staffordshire Tramways Company; Mr. E. Coulson, chairman of the Derby Tramways; Mr. H. Hatchett, secretary South Staffordshire Tramways Company; Mr. A. Dickenson, manager South Staffordshire Tramways Company; Mr. H. Foley, manager Gateshead Tramways Company; Mr. William Anderson, manager and secretary Dublin United Tramways Company; Mr. J. Neal, secretary and manager Liverpool Tramways Company; Mr. J. H. Lynn, manager Bradford Tramways Company; Mr. F. L. Laxton, manager Dewsbury and Batley Tramways Company; Mr. John Waugh, director of the St. Helens Tramways Company; Mr. W. Wharam, manager and secretary of the Leeds Tramways Company; Mr. E. P. Smith, chairman of the Rochdale, Bury, and Oldham Tramways, and Mr. Edward Rothwell, manager; Mr. Moseley, manager of the Burnley Tramways Company; Alderman Priestley, the town clerk of Leeds (Sir George Morrison), the town clerk of Walsall, the deputy town clerk of Leeds (Mr. Jolifle), the Leeds borough surveyor (Mr. Hewson), Mr. I. E. Winslow, manager of the Roundhay Electric Tramway, and most of the aldermen and councillors of the Leeds Corporation, besides a large number of other guests. In addition to the usual toast of "The Queen," that of the President of the United States was heartily received. The toast of the day, "Success to the Roundhay Electric Tramway," was proposed by Alderman Firth, who recapitulated the history of the undertaking from its inception to the ceremony of the day, and gave as his emphatic belief, from what he had seen throughout the whole work, that the undertaking would be a great success.

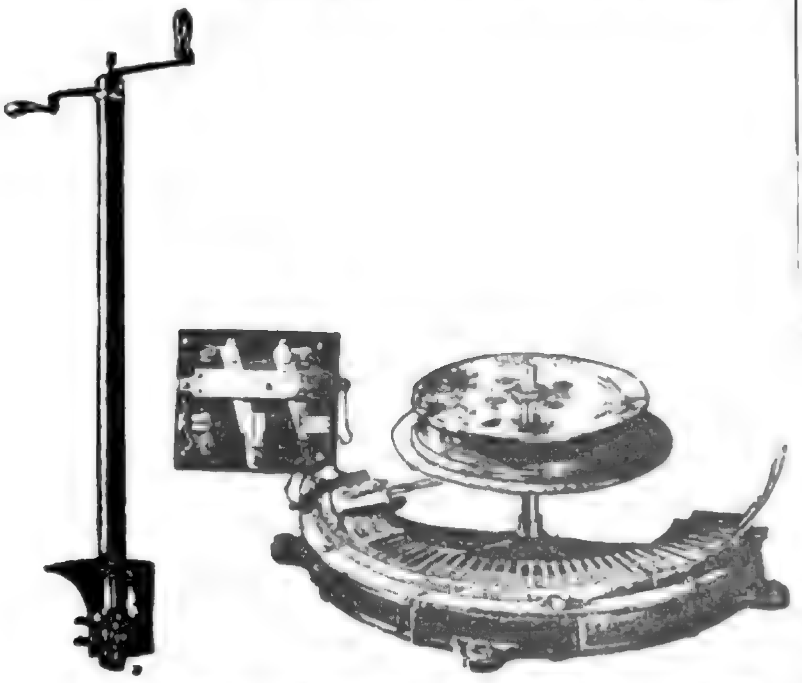

FIG. 14.—Controlling Stand, Tramway Rheostat, and Reversing Switch.

Mr. W. S. Graff Baker was to have replied to this toast, but owing to indisposition, his place was taken by Colonel Church. The Mayor of Leeds replied to the toast of "The Mayor and Corporation," and stated that he was the first man in Yorkshire who put down the electric light for commercial purposes at his works at "Crown Point." Prof. G. Forbes proposed the toast of "The Thomson-Houston Company," and credited Prof. E. Thomson with having done much and good work for the electrical world. He also referred in eulogistic terms to the great financial ability that had been displayed in regard to this company. Mr. Carey responded. The evening concluded with the toast of "The Chairman," and so ended the opening ceremony of the Roundhay Electric Tramway Company.

The employés of the above tramway were given a dinner at the Royal Oak Hotel, Kirkgate, Leeds, on Saturday evening last, October 31. The chair was taken by Mr. J. W. Watkins, engineer of the generating station, who was supported by the following gentlemen: Messrs. J. J. McMahon, the assistant superintendent of the line; J. McGuire, of Messrs. Babcock and Wilcox, of London; J. Maddocks, chief inspector of the highways department, Leeds Corporation; J. Morley, J. Allen, Arthur F. Guy, A.M.I.E.E., of London, and other gentlemen. The dinner to which the assembly sat down was of a very substantial and excellent character. A silver tobacco pouch was presented to Mr. John McMahon, the foreman lineman.

LITERATURE.

The Practical Telephone Handbook. By JOSEPH POOLE. Whittaker and Co., London.

The number of telephone employés in the United Kingdom is large and constantly increasing, yet heretofore there has not been any work to which the junior grades, instrument fitters and inspectors, linesmen and apprentices, could refer for guidance in matters pertaining to their daily round of duty. Preece and Maier's book, "The Telephone," is a mine of information, but its style is not of the most popular order, and much space is devoted to German and other foreign instruments and systems which are interesting to our telephone workers only as curiosities. The author of the present volume, on the other hand, confines himself closely to apparatus in actual use amongst us, or which is earning deserved commendation elsewhere, and eschews theories in favour of practical detail. Mr. Poole enacts the demonstrator rather than the professor. He puts himself by the instrument inspector's side, accompanies him on his fault-finding expeditions, and in a plain, straightforward, easily-understood fashion, tells both how to detect and remedy all the defects to which telephonic apparatus is liable. For this reason, Chapter XIII., on "Faults and their Localisation," is certain to become a great favourite with aspiring juniors, and for its sake alone it would probably pay telephone companies to present a copy of the book to each member of their technical staff. Another good chapter is that on "Intermediate Switches and Switchboards." A young inspector is frequently bothered by recurring cases of bad contact in two-way and other switches, than which nothing can be worse for telephone working. Only one microphone—that on the subscriber's instrument—is, as a rule, wanted, and such supplementary ones as are due to bad joints, loose connections, and faulty contacts are to be sternly deprecated. Economy is not only desirable but necessary in telephone work, but the employment of cheap apparatus, such as switches which depend on their pivots for the line connections, as many still offered to telephone companies do, is not the surest means to attain it. Several good switches are illustrated and described. The same chapter deals with the details of the

Western Electric Company's and other switchboards, and with switchroom fittings of various kinds—matters too little understood by many responsible for the efficient working of such appliances. Signalling apparatus used by subscribers receives good attention. Both push-button and magneto instruments are minutely explained by the aid of numerous diagrams, and directions given for properly fixing them. Multiple switchboards are honoured with a separate chapter, as becomes the importance of the subject, but only the two types most commonly used (the ordinary Western Electric and Scribner's single-cord board) are treated of. It is interesting to note that the author is not enamoured of the single-cord system. One weighty objection he advances—that such boards cannot be adapted hereafter to metallic circuits—is certainly a serious one, for many things point to the ultimate general use of double wires in telephone exchanges, so that money sunk now in fitting up this expensive type of switchboard may not prove in the long run to have been particularly well invested. The experience of single-cord boards has not, so far, been altogether a happy one, for the saving of labour they effect is dearly purchased by the sacrifice of simplicity involved. The retention of the ring-off drop in the speaking circuit is a decided disadvantage which they share with the multiple tables of the more ordinary pattern. It is true that the shunt principle is being adopted in some of the latest boards, although not in such a way as to permit subscribers to ring each other without risk of being disconnected. The only instance with which we are acquainted in which this evil is avoided in a Western Electric multiple is afforded by the board fitted at the late Lancashire and Cheshire Telephone Company's exchange in Manchester, which is provided with ring-off drops in shunt to earth in accordance with Mr. Poole's own plan. It is remarkable that so far back as 1880 the feasibility of working with a shunt of high electromagnetic inertia at the middle of the line should have been recognised and turned to such useful account as was done by Mr. Poole, when designing the switching system which since that year has been characteristic of Manchester. He gave the subscribers in that town the great advantage, which they have enjoyed ever since, of a ring-off signal that could not be confounded with a ring-through. The credit of the shunt system for ring-off purposes has recently been claimed for the British Post Office, but as there was no Post Office exchange in existence in 1880, Mr. Poole's title to priority must be admitted. Some years later a somewhat similar system, due, we believe, to Mr. Walter Emmott and Colonel Harrison, was tried in some of the Yorkshire towns, the necessary distinctive currents being obtained by commutated magnetos instead of voltaic batteries, but it has not survived. Mr. Poole's plan is described in the chapter on "Special Exchange Systems," which likewise deals with the Post Office plan, made familiar by Preece and Maier, the Berthon "direct call," as used in Paris, and the more recently introduced metallic circuit system of the Mutual Telephone Company at Manchester. The Berthon, although decidedly ingenious, is open to serious objection in several respects. It comprises complicated ringing-keys with many contacts to keep clean; it requires a battery of nine cells in each subscriber's office; it depends on relays for ringing; it retains two shunts across the loop—increased to four when a branch switchroom is spoken through—when subscribers are connected; and, as subscribers' loops are earthed for ringing purposes when out of use, the static capacity of the cables is greatly increased, to the detriment of the wires in them that may happen to be speaking. The earthing of the loop is justified on the ground that the joining of the two wires in parallel saves ringing cells, by reducing the resistance; but magnetos, while much simpler, would be independent of such a consideration. Indicator coils are wound to 400 ohms, and the operators have to use two different kinds of ringing-keys; and what, after all, is accomplished? Not so much as with the British Post Office system, and nothing that is not equally well performed by Poole's. The Mutual Telephone Company's system is an ambitious one, for it aims (by the help of the Mann call wire) at the exclusion of electromagnets altogether from the line, whether in series or shunt; and while recognising the value and taking advantage of metallic circuits and multiple switchboards, affects an extreme simplicity. Should the Mutual engineers succeed in overcoming the difficulties incidental to an undertaking combining so many unusual features, a system, "as near a perfect telephone exchange as one can conceive," will, as the author remarks, be their reward. The same chapter describes the Law and Mann call wires, about which controversy has lately arisen. Mr. Poole contrasts them very neatly. He says that in the Law the subscribers are joined *in series*, no earth being employed, while in the Mann subscribers are in derived circuits to earth. Slight as this variation may appear to the cursory investigator it constitutes all the difference practically between an indifferent and a very good—by many held to be the best of all—system. The Law was fitted experimentally at Blackburn and Glasgow in 1881 by Americans who had had experience of it on the other side, and a little later it was likewise put up in Calcutta and Bombay. Failure resulted in every instance. The Mann was first erected in Dundee, in 1882, and became at once an unqualified success. Since it has gradually spread, until now some 20 exchanges in Great Britain are worked by it, and others are being built, while it is also coming into favour in the United States. The chapters on "Test Room Appliances," "Outdoor Construction," and "Long-Distance Working," desire careful consideration, although some of the subject-matter has already been given in Preece and Maier. The relative merits of twisting and crossing aerial metallic loop trunk lines are discussed. There is no doubt that twisting answers its electrical purpose perfectly, but it seems equally certain that the continuous revolution of one wire about the other is not a real necessity, for perfectly silent lines are obtained by running the wires straight with an occasional termination and cross connection, a plan which is not only more sightly, but also cheaper and less liable to accident. The first really efficient metallic circuit copper trunk lines in Great Britain were erected in Scotland, and were crossed, not twisted; and it is noteworthy that the cross finds favour in America and most continental countries. The book, which is profusely illustrated, also contains chapters on "Batteries," "Transmitters," "Receivers," and "Underground Work," with a short historical sketch. While not absolutely free from slips, these are of a minor order, and detract nothing from its value as the only treatise devoted to the minutiæ of telephone exchange working yet published. That the task of breaking the ice has fallen to such competent hands is a matter for congratulation to all concerned.

CONSIDERATIONS GOVERNING THE CHOICE OF A DYNAMO.*

BY PROF. E. P. ROBERTS.

(Concluded from page 425.)

Heating.—Excessive heat will gradually carbonise the insulations of wires, and render them brittle and destroy their insulating properties. A safe temperature should not be exceeded after a three hours' run at full load.

What temperature is safe depends upon what the insulation will stand. In other words, high temperature is only injurious, from the standpoint of reliability, because the insulation may be deteriorated, and the extent of insulation required is a function of the P.D., which may be increased much above its normal value when the circuit under consideration is suddenly opened, particularly if such consists of many turns about an iron core.

When the windings are of considerable depth the external layers are cooler than the internal. In case of an armature, the external layers will be much cooler when running than those after stopping, as then the conduction of heat will not take place as rapidly, owing to less cool air coming in contact with the wires, and the temperature of the external wires will become more nearly that of the internal layers.

In any case, it is advisable not to have the temperature rise so high that the back of the hand cannot be held against the wires.

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* Paper in the *Journal* of the Association of Engineering Societies.

Sparking.—The action of the commutating and collecting devices is in many respects a guide to the electrical action of the dynamo. If the dynamo be of the open coil type, and designed for high E.M.F. and small current, a spark of considerable length can be run without burning the commutator. Such a spark may be run for a year or more on a machine properly attended to, and very little wear be perceptible. In closed-coil machines, and in all large "quantity" machines, the less spark the better. Many may now be observed in operation with almost no perceptible spark, or even scintillation. If the field and armature are electrically balanced this can be accomplished, but the art of so balancing them is outside the province of a station constructing engineer. Whether the brushes are to remain unmoved and non-sparking for changes of load, or whether automatic or hand movement must necessarily or advisably accompany such changes, depends often upon the place where the dynamo is placed, and the character of the work desired. In other words, whether constant attendance is necessarily provided for other work than to shift brushes, and therefore will always be at hand; and whether large percentage variations are liable to occur at any moment and unexpectedly. Generally speaking everything should be automatic, but sometimes government is obtained by such a multiplication of devices, and accompanied by so many losses of power, that the advantages are not commensurate with the losses, and particularly with the attention necessarily given to keeping the automatic devices in order. The cost of time taken for this by an expert may even exceed that of comparatively unskilled labour for hand regulation.

The commutator and brushes constitute an important part of the dynamo, since the successful collection of the current depends upon their satisfactory operation. As shown before, the requisite quality of the commutator is that it presents a uniform, smooth, and clean surface moving with moderate peripheral speed, against which the brushes may maintain easy but sure contact. Likewise the condition to be met by the brushes and their attendant mechanism is that they maintain sure and continuous contact with the revolving commutator, at the same time being well connected to the stationary conductor. This requires that the brush shall be of some good conducting material, or that the holder grasp it as near as practicable to the commutator. The brush or the enclosing holder should have a certain amount of springiness. They should preferably be capable of adjustment while running without opening the circuit. Much ingenuity has been exercised upon the development of satisfactory brushes and holders, and many excellent designs are to be found on different machines.

In a few machines the brushes are made to bear tangentially upon the commutator, but in most cases they bear obliquely. Tangential brushes have only a small surface of contact and are easily kept in order. The principal points to be looked after are to see that the brushes do not get worn through at the line of contact, and that they retain their elasticity and certainty of contact.

With the brushes set at an angle the surfaces of contact with the commutator are wider, being usually best when equal to the circumferential width of one commutator bar. The brushes should be filed off square and bevelled to the desired angle, then set in the holders or clamps so that the bevelled surfaces bear evenly upon the commutator; they should then be fastened tightly so that they cannot work loose or change position, and the springs adjusted to the proper tension for securing good contact with the minimum friction. The brushes should be kept clean so as to make good electrical contact both with the commutator and the holders. The ends should not be allowed to become dirty, rough, or ragged, and may be cleaned occasionally by washing in benzine. As the brushes wear they gradually change their angle and their position on the commutator and leave the non-sparking point. They should, therefore, be trimmed occasionally and reset. Care must be taken that the brushes touch the commutator at diametrically opposite points, and, to facilitate resetting, a pair of opposite bars should be marked with a centre punch or chisel mark.

It is desirable, especially for machines giving large quantity of current, that there be two or more brushes on a side, both to reduce the resistance by increasing the amount of surface between brush and commutator, and so that the operation of the machine will not be entirely dependent upon the proper working of any one brush. When there is more than one brush on a side they should all be set in a line so as not to cover a wider angle on the commutator than should be covered by any one brush, unless such separation of brushes is part of the means for regulating the dynamo.

"Carbon brushes" have recently come into quite general use and are popular, since they do not require so much attention and care as those of copper. They also reduce that part of the sparking due to the short-circuiting of armature coils, when the brushes touch two adjacent commutator bars, since the carbon brushes have more resistance than those of copper. In many cases the carbon brushes simply replace the copper ones, and are used in the same holders, but more frequently special holders are used.

When the commutator is in good order and the brushes well set, so that there is little sparking, the commutator will acquire a glazed surface, and will run for months with no other attention than being occasionally oiled. To reduce the abrasion between commutator and brushes, a certain amount of lubrication is desirable; but this should not be excessive, since lubricators, as a rule, are insulators, and their presence between the brushes and commutator, except in very small quantity, introduces injurious resistance. A small amount of resistance from this source is less objectionable with high-tension machines than with low-tension. Too much lubrication will prevent the brushes from making good contact, and the sparking that follows will char the oil and insulation, and cause more or less short-circuiting of the commutator. Some makers provide automatic commutator oilers, but for most cases occasional wiping of the commutator with a piece of cloth or felt impregnated with oil or vaseline is sufficient. For low-tension machines a convenient and satisfactory plan is to put a drop or two of oil on a clean finger, shake off the excess, and rub the finger over the commutator. Some of the carbon brushes are partially composed of graphite, which furnishes the desirable amount of lubrication. Another plan is to boil the carbons in vaseline, which will serve the same purpose without lessening the conductivity of the brush.

When the surface of the commutator becomes dark and dirty it should be scoured off with fine sand-paper. The commutator should not be allowed to get dry, since it then scours, and there is more or less cutting of both brush and commutator, accompanied with undesirable throwing of copper and carbon dust.

Construction.—This can be suitably examined under the heads of material, workmanship, balance of rotating parts, methods of manufacture, and insulation.

Material should be what it is represented to be. There is little danger of an efficient dynamo being lacking under this head, unless, possibly, a flaw be found in the shaft or pulley.

Workmanship is to be judged from the standpoint of a machinist who has a knowledge of the electrical functions of the different parts. An electrical machinist used to dynamo work is needed to find flaws in workmanship.

Balance.—It is very important, not only for quiet but for continued running, that the revolving portion should be in good running balance. If the armature is of the disc pattern on a long shaft, a static balance will give a "running" or dynamic balance. If, however, the armature be of the drum pattern, a system such as is used by the Alliance Company or a machine of the character designed by the writer should be used.

Method of Manufacture. (Gauge or Interchangeable System.) It seems hardly creditable that in these times and in this country any machine made in quantities should not be made to gauge; but sometimes it is a fact that a part of a machine "made to gauge" breaks, and the new part does not, unaccountably perhaps, fit.

Insulation.—The insulation of any machine is usually designed with reference to the E.M.F., and for safe running in a dry locality. If dampness or injurious vapours or excessive heat be present, special insulation should be provided. When a dynamo has become wet it can be dried out by means of a current. It is best to obtain such current from an external source, as then the P.D. between continuous portions is only that due to the R, and not that generated in such portions when acting as a dynamo. If time is not of importance, it can be dried with more safety by placing it upon a boiler and having the core of the magnet rest upon the shell or dome. This method will, generally, take two weeks to dry out a deep winding.

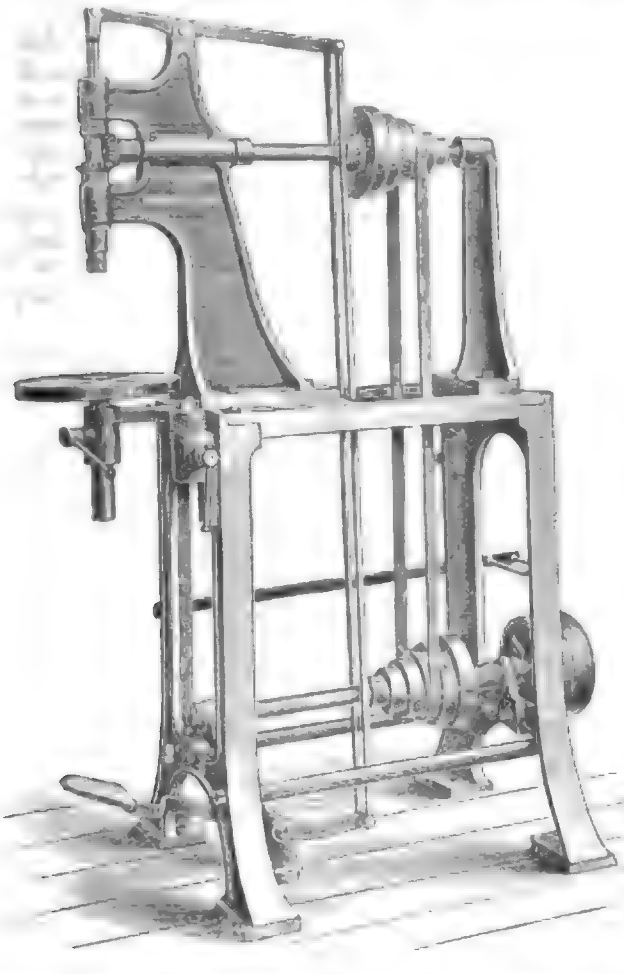
If an electrical engineer be employed to examine a dynamo, he may not actually write out his opinion under each of the above headings. He will determine the characteristics and horse power consumed, and many of the other points will be merely considered together under the head of excellent, fair, or poor in electrical or mechanical details, or in both.

An electrical engineer who has not had enough experience to grasp, as it were, intuitively the detail feature and decide thereon without actual analysis, is very liable to a more or less serious omission and regret it afterward, unless he proceeds in a systematic manner. In any case system is advisable, and clients will have a better opinion of a paper which take up its subject and deals with it fully and comprehensively than if generalities only be presented, and those of the character of the Delphic oracle.

TRADE NOTES—ELECTRICAL AND MECHANICAL.

THE "HANDIEST" DRILLING MACHINE.

Messrs. W. T. Glover and Co., of Manchester, are introducing a new and improved drilling machine, illustrated herewith, which they contend is the handiest machine in the market. It is adapted for drilling holes from $\frac{1}{64}$in. to $\frac{3}{4}$in. in diameter. It has five speeds, and a movable table, which can be turned to one side when it is desirable to drill anything resting on the floor. It is instantaneous in its action, the drill being brought down on the work by a simple pressure of the foot on a treadle, thus leaving both hands at liberty to attend to the work being done. It stands on its own table. It carries a long strap, and thus develops more than ordinary power, and considering its advantages is sold at a very low price. Its gross weight is $5\frac{1}{2}$cwt., and net weight 4cwt.



FINCHLEY LOCAL BOARD.

The following report has been presented by Mr. Francis Smythe, the engineer and surveyor to the Board :

Gentlemen,—In accordance with the instructions of your committee I beg to report as follows in regard to an installation of electric lighting for the parish of Finchley and the probable cost : If an electric current be compared to water being pumped up to a certain height through a tube or pipe, the following are the units used in electrical science to represent the measurements of the various forces brought into play :

Volt.—The measure of E.M.F.

Ampere.—Represents the strength of the current in electricity or the speed at which the water travels through the pipe, taking into consideration the friction caused by the surface of the pipe and its inclination.

Watt.—The measurement of the amount of current or of volume of water. The E.M.F. produced by 1 i.h.p. is calculated to be 746 watts.

Ohm.—The practical unit of friction or resistance offered to the current by the conducting medium.

It is obvious the greater the inclination and the rougher the inside surface of the pipe through which the water is passed, the greater will the flow of the water be impeded. So it is with electricity ; the smaller the sectional area, and the worse the conductive power of the material, the greater will be the resistance. The unit of measurement adopted by the Board of Trade is a current of 1,000 amperes flowing under an E.M.F. of one volt during one hour.

The different forms of lamps are arc lights, electric candles, semi-incandescent lamps, and incandescent lights. The most powerful of these lights are the arc lamps, which may be described as follows : If a conductor is cut, and a small space left between the two ends of the cut conductor, great resistance is created and intense heat caused by the current forcing its way through the intervening space. If pieces of carbon, with pointed ends like a sharpened pencil, are attached to the two ends of the conductor, and these pointed ends are brought close to one another, but not allowed to touch, a brilliant light, called the voltaic arc, is produced. In order to keep the carbon points always at one distance, various mechanical contrivances, governed by the electric current, are attached to the lamps.

Electric candles are somewhat similar to arc lights ; but instead of having regulators attached to them to always keep the carbon pencils at one distance from one another as they burn away, have some other medium to pass the current between the points of the carbons ; this medium would, of course, be a bad conductor in order to cause the necessary resistance to produce the light.

Semi-incandescent lights are lamps having carbon rods pressing against a block of carbon or some material from which a white heat can be obtained without instantaneous destruction.

Incandescent lamps are lamps which have an intervening space between the conducting wire filled up with a carbon filament of small sectional area. This intervening space being in an hermetically sealed glass globe, from which the air has been excluded, the filament is heated without being destroyed, as it would inevitably be if it were in the open air.

For outdoor illumination the arc lamp is by far the cheapest and most effective ; as a rough estimate one indicated power may be taken to be able to give a light of 1,200 candles, but the greater the number of lamps on a circuit the greater will be the capability of the indicated horse-power. The lamps should be fixed at such a height as will prevent the glare from affecting the eyesight, and for this reason, as also that the light is more evenly distributed, it is best to have less powerful lamps and a larger number of them. By so doing, the poles or brackets to which they are fixed need not be of such great height. The cost of renewing the carbons amounts to, roughly, about 1d. per hour.

Incandescent lights of 8 c.p. are the most useful for indoor lighting. It is much the best to have a number of small lights than have the light concentrated in a lesser number of lights of higher power: first, on account of the better distribution of the light, and secondly, unlike gas, the electric light cannot be turned down —one must have the full light or none.

An expert would, I feel sure, advise you in adopting for street lighting a combination of the arc lamp and the incandescent lamp. Wherever the latter has been used exclusively for outdoor lighting it has turned out to be a failure for one or two reasons :

1. The installation has been in the hands of some company who, to make as much profit out of it as possible, always overrate the illuminating power of the lamps. The manufacturers of the lamps do the same thing.

2. The idea of the public in regard to electric lighting is that it is a most brilliant light, not thinking it is measured or ought to be measured the same as any other commodity ; they are therefore disappointed if they do not get a more brilliant illuminant, and are rather apt to make comparisons that are not favourable to the electric light.

3. It appears to me the incandescent light does not diffuse its rays to the extent of gas ; for instance, an incandescent light of equal intensity to a gas jet will bear favourable comparison to the jet in a room, but not outside.

Taking all these things into consideration, it is always advisable to substitute in street or public lighting a larger power light in electric lighting. I have not the slightest doubt this has been the cause of the discontent of the public when electric lighting has taken the place of gas.

There are at present 408 lamps in the district, and in estimating I propose to give you the approximate comparative cost of lighting these 408 lamps only, but as the only addition to this cost for the prospective lighting required to be done will be additions to engines, extra mains, and additional working expenses, as buildings, chief mains, etc., will already have been provided for, I propose also to give you the cost of what will likely be required, if public and private lighting be combined.

The bare cost of lighting the existing lamps with electric lamps instead of gas jets is, in my opinion, fallacious; inasmuch as the initial cost per lamp would be much more in an extended district as Finchley is, than if private lighting be provided for, as the provision for three times the quantity of candle-power would cost but a very small proportion more. Then, again, the cost per hour of a gas light remains constant, no matter how long the light is kept burning. On the other hand, the longer the electric light is kept burning the cheaper it becomes, as it is only a question of extra fuel, wages of drivers, and a little more for depreciation; the interest on capital account remains the same. I mention this as there is no doubt in the near future the lighting will be kept up through the night. I might also mention the cost of production of electric lighting is being rapidly cheapened by improvements in engines especially made for the purpose, belting and dynamos, and more especially in the lamps, and, as an instance, standard works of two years ago gave 120 candles as the production of 1 h.p. indicated, yet at the present time certain electrical companies are producing 140 candles per indicated horse-power.

As the financial year is not yet ended, I am unable to give the actual cost, but during the year ending March 25th, 1890, the cost per lamp was £2. 0s. 6d. per lamp, and this multiplied by 408 lamps will be £826. 4s. Whereas 1 i.h.p. may be taken to produce 140 candles in incandescent lamps, the same power would be equal to 850 candles of arc light. This being so, I should recommend the general use of the arc light in all the main thoroughfares, leaving certain isolated portions of the district to be lighted by incandescent lights; but on this report it will be sufficient for your purpose to give an approximate cost of an installation. I will therefore simply provide for a substitution of 32-c.p. glow lamps in the place of our present 5ft. per hour 14-candle gas jets used in street lamps.

As the district of Finchley is a straggling one, and there would be a large length of unproductive main, I should certainly recommend an alternating current of high tension, with the use of transformers, as being the cheapest system, and my estimates would be based on this system.

The following is my estimate for lighting the existing 408 lamps with 32-c.p. glow lights:

	£	s.	d.
Site, building, setting boilers	1,200	0	0
Three 60 i.h.p. engines and boilers	2,200	0	0
Two dynamos	375	0	0
Mains	9,000	0	0
Wiring and connecting lamps	408	0	0
Fixing machinery, etc.	200	0	0
Transformers, tube well, etc.	400	0	0
Law and other costs	217	0	0
	£14,000	0	0

Annual expenses—			
Repayment loan and interest £1,400 at £5. 8s. 9d.	761	5	0
Fuel	230	0	0
Engine driver and lamp attendant	150	0	0
Stoker and help to lamp attendant	50	0	0
Renewals of filaments, painting lamps	60	0	0
	£1,251	5	0
£1,251. 5s. divided among 408 lamps	3	1	4
Deduct existing cost	2	0	6
Cost of electric light over gas	£1	0	10

It must be remembered, however, that at present the lamps are only lighted for eight months in the year, and then only until midnight, and as no doubt they will have to be kept alight all night the year round, it will mean a further cost of 9s. 6d. per lamp, but only about half that for the electric light.

In order to be able to make an estimate for private lighting, I have obtained the following returns—viz.:

Houses assessed at £30 but under £40	£415
Houses assessed at £40 but under £50	313
Houses assessed at £50 and above	409
415 houses I estimate will have four jets	=1,660
313 houses I estimate will have six jets	=1,878
409 houses I estimate will have nine jets	=3,681
Total	£7,219

The following is the result of enquiries in regard to churches, schools, and public places:

Total number lights.	Gas consumed.	Cost per annum.
2,240.	2,471,000ft.	£523. 5s. 11d.

Assuming that one-fourth of the above number of lights will be required over and above the public lamps, this will give, say, 3,000 lights (private) to be provided for in the installation. An eight-candle incandescent lamp will light interiors equally as well, if not better, than the gas jets, as supplied in Finchley, so that I shall estimate for that light.

The following is an approximate estimate of the cost of providing for an installation of 3,000 8-candle and 408 32-candle incandescent lights:

Site, buildings, setting boilers	£1,400
Four 100-h.p. indicated compound engines and boilers (one in reserve)	4,500
Four dynamos (one in reserve)	840
Mains, transformers, etc.	10,800
Wiring and connecting lamps	408
Fixing machinery, piping, etc.	400
Law and other costs, including sinking tube well	652
Total	£19,000

Annual expense—			
Repayment of principal and interest upon £19,000 borrowed at 30 years, at £5. 8s. 9d. per cent.	£1,033	2	6
Fuel, oil, etc.	950	0	0
Electrician	150	0	0
Engine driver	80	0	0
Stoker and lamp cleaner	120	0	0
Renewal of filaments and painting columns	100	0	0
	£2,433	2	6
Add unforeseen expenses	66	17	6
	£2,500	0	0

The new streets will be completed next summer, and this will add about 40 more lamps to the present number.

In the above estimate I have allowed only for the existing number of lamps for street lighting, as at the first start of an installation there would be a smaller quantity of lighting for private purposes than that provided for in estimate.

The electrician would be employed a portion of his time superintending connection to private houses, and would be charged to that account when so occupied.

The following would be the receipts from a supply of 3,000 lights of 8 c.p., allowing 300 candles per hour, which is nearly equivalent to the Board of Trade unit:

3,000 lights multiplied by 8 candles = 24,000 candles per hour.

24,000 candles multiplied by 4 hours per day = 96,000 candles burnt per day.

69,000 candles multiplied by 365 days = 35,040,000 candles burnt per year.

Divide 35,040,000 by 300 = 116,800 Board of Trade units.

116,800 multiplied by 6d.	=£2,920 total receipts.
Deduct for depreciation	920
Actual estimated revenue	£2,000

This leaves a difference of £500 between annual expenditure and receipts, which would be the cost of lighting public lamps. It will be noticed I have charged 6d. per unit for private lighting; this would be equivalent to gas at 3s. 6d. per 1,000ft.

The following are the systems of electric lighting:

Direct Supply.—By this system mains are laid from one or a number of central stations. The current is then supplied direct to the houses at a low E.M.F., but the large cost of the mains makes it only practical for supplying the current within a short distance of the station.

Transformer System.—The current is conveyed at a high potential along the mains to converters where required, by which the E.M.F. is reduced for domestic supply.

The Accumulator System.—The current is generated at a central station and conveyed to distributing stations, where are fixed accumulators, from which it is again distributed at a low potential to the various houses. By this means a reserve supply is always obtained, and incandescent lamps last longer on account of the even tension to be obtained by the aid of the accumulators. There is, however, a loss of, say, 30 per cent. from the use of the accumulators.

For an installation in a scattered district like Finchley, I have no doubt the transformer or accumulator system would be adopted.

EXCURSIONS TO THE CHICAGO EXHIBITION.

Many of our readers may be interested in knowing that the committee of the Polytechnic Institution, Regent-street, London, are adding to their already unique series of continental tours, trips to the Chicago Exhibition in 1893, specially intended for workingmen and others whose means will not permit of visiting the New World under ordinary circumstances. The authorities have already entered into a contract with the Inman Steamship Company, by which means those who participate in these excursions will travel by the fastest vessels afloat. Parties will leave Liverpool weekly during the months of June, July, and early part of August, by the magnificent steamers "City of Paris," "City of New York," "City of Chicago," "City of Berlin," and travelling by those fast vessels the whole tour will be able to be accomplished within one month. The proposed arrangements are that two days shall be spent in New York, a visit to Philadelphia and Washington will also be made, proceeding from thence to Chicago, where each party will be allocated for six or seven days. The return journey will be continued through Buffalo to Niagara, visiting the world famous falls, the journey back to New York being taken down the Hudson river, the views along which comprise some of the grandest scenery imaginable. The committee hope that the whole round excursion, including accommodation for the period, will not exceed 25 guineas, which is only slightly above the fare for the ocean journey alone during the season by the above steamers.

Arrangements have been made thus early to enable those who desire to take part to put by so much per week towards the required amount; also to enable many who have, as a rule, but a fortnight's holiday, to forego their holiday next year, and get a special holiday of one month in 1893. Already over half the places have been applied for, and any of our readers who are desirous of taking part in these trips should send in their application to the Polytechnic without delay. Mr. Douglas Hogg (the son of Mr. Quinton Hogg, the president of the Polytechnic) and Mr. Mitchell, the secretary of the Polytechnic, leave England shortly to complete the Trans-Atlantic arrangements. Last year special series of excursions were run to Norway, Madeira, the Ardennes, Switzerland, etc., and during the last three years over 9,000 persons have participated in the excursion arrangements of this well-known institution.

LONDON COUNTY COUNCIL.

The Highways Committee of the London County Council, at the meeting on November 3, presented the following notices under Electric Lighting Acts and Orders:

We have considered a notice, dated 15th October, 1891, from the London Electric Supply Corporation of intention to lay distributing mains, consisting of concentric lead-covered cables in iron pipes in Glasshouse-street. There is nothing unusual in what is proposed, and we recommend:

> That the sanction of the Council be given to the works referred to in the notice, dated 15th October, 1891, of the London Electric Supply Corporation, upon condition that the company do, before commencing the work under this notice, submit for the approval of the committee the drawings of any boxes which it may desire to construct; and do give two days' notice to the Council's chief engineer before commencing any of the works; that the mains be laid under the footways, and be kept 9in. below the under side of the paving wherever it is found practicable to do so; that where the mains cross the carriageways they be kept at the same depth below the concrete or the road material as the case may be; that all pipes or openings from or into the boxes shall be of such shape as to remove all risk of injury to the covering of the cables; that all cables crossing the boxes shall be supported from below in the boxes; that all service lines or small cables shall be protected where leaving the boxes by an extra lead covering, or by wooden stoppers, and shall also have a copper wire of sufficient size carried from the service to the main cable in good connection with the lead or iron outer casing; and that the ends of all mains terminating elsewhere than in a box shall be securely protected by iron caps in addition to any other covering.

Two notices, dated 15th and 21st October, 1891, respectively, have been given by the Notting Hill Electric Lighting Company, of intention to lay mains—(1) crossing Westbourne-grove, and (2) in Palace-gardens-terrace and Brunswick-square. The proposed works are of the ordinary character, and we recommend:

> That the sanction of the Council be given to the works referred to in the two notices, dated October 15th and 21st, 1891, respectively, of the Notting Hill Electric Lighting Company, upon condition that the company do give two days' notice to the Council's chief engineer before commencing the work; that the cover-stones of the culverts under 20in. wide shall be not less than 2in. thick, and of the wider culverts not less than 2½in.; and that where the culvert crosses the carriageway, there shall be at least 9in. thickness of Portland cement concrete above the cover-stones of the culvert, in addition to the road material.

The Westminster Electric Supply Corporation has given notice, dated October 17th, 1891, of intention to lay mains in Castle-lane, Westminster. There is no objection to the proposed works, and we recommend:

> That the consent of the Council be given to the works referred to in the notice, dated October 17th, 1891, of the Westminster Electric Supply Corporation, upon condition that the company do give two days' notice to the Council's chief engineer before commencing the works; that the mains be laid under the footways wherever it is found practicable to do so; and that the covers of the street boxes to be used shall consist of iron frames filled in with material to suit the paving.

We have also to report the receipt of the following notices given in accordance with the resolution of the Council to accept four days' (instead of one month's) notice in respect of the laying of service lines from mains already laid.

From the St. James and Pall Mall Electric Lighting Company: 16th October, 1891, to 57, Pall-mall; 17th, to 23, Piccadilly; 20th, to 172, Regent-street; Mr. T. Hodgkinson's, Pall-mall-place; and the Stereoscopic Company's premises, Glasshouse-street; 21st, to 210 and 211, Piccadilly; and 18 and 19, Pall-mall; 27th, to 99, Regent-street; 29th, to 151, Regent-street.

From the London Electric Supply Corporation: 16th October, 1891, to 152, Westminster Bridge-road, and to 131, Newington-causeway, and 120 and 132, Borough High-street; 16th, to the Surrey Theatre; 26th, to the Council's offices, Union-road, 21, Parliament-street, 4, Dover-street, and the Alhambra Theatre; 28th, to 22, Old Bond-street, and King's Head Inn, Borough High-street; 29th, to 14 and 15, Cockspur-street.

COMPANIES' MEETINGS.

CROMPTON AND CO.

An extraordinary general meeting of this Company was held at the offices, Mansion House-buildings, E.C., on Tuesday, for the purpose of approving a resolution increasing the capital of the Company by the issue of preference shares.

Mr. R. E. Crompton, chairman, presided, and explained the reasons for increasing the capital. Three years ago the Company was a private partnership, which began with small beginnings and got to occupy a not inconsiderable position. The growth of the business since it had been taken over by the Company had been continuous, and quite as rapid, if not more so, than when it was a private concern. The turnover had advanced by leaps and bounds. Each year the percentage of increase had been very large, 30, 40, and 50 per cent. It now stood at a figure two and a half times what it was under private management. When it was turned into a Company, the calculations were based upon no such rate of increase, and so they had found themselves crippled, and had had to refuse valuable orders because they had not sufficient working capital to carry them out. He did not mean that they had had to refuse all orders, but only such as required a considerable amount of working capital to execute. Considering that their present capital had been invested in such a satisfactory manner; considering that not only had the preference interest been easily earned, but that there had been a large margin over to pay a dividend on the ordinary shares, he thought it was evident that further capital must be raised. After considering the various means of doing this, the Directors had decided, after obtaining competent advice, to increase the preference capital. When they had plenty of capital they could pay cash for all their materials, and so get the benefit of considerable discounts. The persons most affected by this increase of capital were the ordinary shareholders, who in this Company were very few, consisting entirely of the old owners of the firm—that was Mr. Albright and himself (Mr. Crompton). They could not possibly have sanctioned this step without carefully weighing the cost, and the effect it would have upon them. Having done this, they had come to the conclusion that they were justified in sanctioning the increase, and that they would participate in the benefits. It had been suggested to the Board that the new shares should be issued at a premium, but they had thought it better to divide them into two parts, and issue 5,000 at par (their present preference shares being at a considerable premium) and the Directors would consider whether they should issue the remainder at a premium or not. They had obtained the opinion of the shareholders on the matter by proxies, and they had received proxies for more than three-quarters of the shares. He then moved a resolution increasing the capital by the issue of 10,000 preference shares of £5 each, to rank *pari passu* with existing preference shares, and to be issued as the Directors may think fit.

This was seconded by **Mr. J. F. Albright**, and carried unanimously.

There was no other business before the meeting.

MONTEVIDEO TELEPHONE COMPANY.

The ordinary general meeting of this Company was held on Friday last at the offices, Abchurch-lane, E.C.

Mr. Arthur Holland presided, and said that the accounts, compared with those of the previous year, showed that the subscriptions had diminished by £2,604, while the London expenses had risen by £75, and those at Montevideo by £1,051. They had written off for bad and doubtful debts last year £660, and this year £852. They had also incurred a loss of £332, owing to defalcations on the part of their collector at Montevideo. The consequence was that the net profits during the last 12 months had diminished by £5,381. The number of subscribers who had left them was 500, but 315 others had joined them. As to the future, much would, of course, depend upon the state of Uruguay, and upon the harvest and wool clip on the River Plate. He concluded by moving the adoption of the report.

The motion was seconded by **Mr. T. D. Peters**, and adopted.

COMPANIES' REPORTS.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.

The report of the Directors for the half-year ended June 30, 1891, states that the total earnings amounted to £104,962, an increase of £15,116 compared with the half year to June 30, 1890. From the above total earnings has been deducted the sum of £11,121, paid in respect of traffic receipts between March, 1889, and December, 1890, hitherto under dispute. The working expenses amounted to £38,638, a decrease of £1,870. Including the amount brought forward from 1890 (£6,070) and the dividend received upon the shares held in the Platino Company to June 30, the balance to the credit of the revenue account is £79,782, from which has to be deducted £12,866 for debenture interest and £6,233 for the debenture redemption fund, leaving £60,682, of which £25,000 has been placed to the reserve fund. This leaves £35,682. The Directors recommend the payment of a dividend of 6s. per share, free of income tax, on the ordinary shares for the half-year, being at the rate of 4 per cent. per annum, carrying forward £6,470.

CITY NOTES.

Eastern Telegraph Company.—The receipts for October were £60,784, as against £59,589 for the same period of 1890, an increase of £1,195.

Cuba Submarine Telegraph Company.—The estimated receipts for October were £3,200, as compared with £3,310 in the corresponding month of last year.

Direct Spanish Telegraph Company.—The receipts for October amounted to £2,436, as against £2,779 in the same period of 1890, showing a decrease of £343.

Eastern Extension Telegraph Company.—The receipts for October amounted to £42,246, as against £47,117 in the corresponding period, showing a decrease of £4,871.

Great Northern Telegraph Company.—The receipts for October were £24,400, making the total since January 1 £237,800, against £232,800 in the corresponding period of 1890, and £220,200 in 1889.

City and South London Railway.—The receipts for the week ending November 1 were £802, as compared with £756 for the week ending October 25. The total receipts for the four weeks ending on the latter date were £3,045.

Business Notice.—Messrs. G. E. Bellis and Co., engineers and boiler makers, Ledsam-street Works, Birmingham, inform us that on Monday next they will open a London office at Westminster-chambers, 9, Victoria-street, S.W., under the management of their London representative, Mr. W. Crawford, in order to provide the necessary facilities for their rapidly-increasing London business.

PROVISIONAL PATENTS, 1891.

October 26.

18421. **A new or improved electric lighting system.** James Merrill Ormes, Norfolk House, Norfolk-street, Strand, London. (Sylvanus L. Trippe, United States).

October 27.

18423. **An improved telephone combination.** Sir Charles Stewart Forbes, Baronet, 21, Finsbury-pavement, London

18431. **Improvements in secondary batteries.** Montgomery Waddell, Justus Buckley Entz, and William Alfred Phillips, 70, Market-street, Manchester. (Complete specification.)

18432. **A portable electric illuminating advertisement.** Sarah Jane Rollason, 50, Goldhurst-terrace, South Hampstead, London.

18436. **Improved apparatus for measuring and recording electric currents.** Sir William Thomson, 154, St. Vincent-street, Glasgow.

18451. **Improvements in telephonic switching apparatus.** Alfred Rosling Bennett, 22, St. Alban's-road, Harlesden, London.

18477. **A depolarising liquid for galvanic batteries.** Oscar Schlesinger, 77, Chancery-lane, London.

18505. **A new or improved electric circuit controller or appliance.** William Bingham Cleveland, 34, Southampton-buildings, London.

18510. **Improved electrical apparatus for indicating the time at which workmen's or other tickets or the like were placed therein.** Frederick August Kohl and Charles Potthoff, 9, Warwick-court, Gray's Inn, London.

18522. **Improved method of and apparatus for welding or working metals electrically.** William Phillips Thompson, 6, Lord-street, Liverpool. (Charles L. Coffin, United States.) (Complete specification.)

18524. **Improvements in insulators or insulating supports for electric conductors.** William Phillips Thompson, 6, Lord-street, Liverpool. (Robert Hewitt and Franklin Leonard Pope, United States.)

October 28.

18534. **Improvements in electric telephonic instruments.** Alexander Marr, 70, Market-street, Manchester.

18551. **Improvements in or relating to electrical terminals.** Charles James Hall, 433, Strand, London.

18595. **Improvements in electric meters.** Haydn Thies Harrison and George William Budd, 46, Lincoln's-inn-fields, London.

18597. **Improvements in electrolysis.** Emile Andreoli, 28, Hatton-garden, London. (Complete specification.)

October 29.

18626. **Improvements in the construction of electrodes for use in the electrolysis of solutions.** James Charles Richardson, 23, Claremont-square, Clerkenwell, London.

18627. **Improvements relating to electrodes to be used in the electrolysis of solutions.** James Charles Richardson, 23, Claremont-square, Clerkenwell, London.

18629. **Improvements in electric dynamos and motors.** William Terrell Garnett, Sunbridge-chambers, Bradford, Yorkshire.

18646. **Improvements in electric motors and dynamo machines.** Henry Chitty, 13, Brackley-terrace, Chiswick, Middlesex.

18641. **Improvements in electrical apparatus.** Barnabas Frederick Kelly, 77, Colmore-row, Birmingham. (Complete specification.)

18650. **Improvements in electrical switches.** The Electrical Accessories Company, Limited, 5, Macclesfield-street, London.

18653. **Improvements in means, electrically operated, for retarding and arresting the motion of trains, applicable also to tramcars.** Nakle Shagouri and John Herbert Hale, Bristol Bank-buildings, Bristol.

October 30.

18714. **Improvements in the regulation of gas and oil engines for electric lighting purposes.** Francis Edward Gripper and Simon Coyle, 19, Great George-street, Westminster, London.

18716. **Improvements in electricity meters.** Arthur Wright, 26, Park-crescent, Brighton.

18721. **Improvements in portable electric lamps or lights for domestic use and other purposes.** James Dixon, Bank-buildings, George-street, Sheffield.

18723. **Improvements relating to resistance frames and the like used for electrical purposes.** Charles Scott Snell and Woodhouse and Rawson United, Limited, 88, Queen Victoria-street, London.

18726. **Improvements in the cores of electric coils.** Alexander Marr and Arthur Thomas Collier, 70, Market-street, Manchester.

18733. **Improvements in and connected with electric telephonic apparatus.** Alexander Marr and Arthur Thomas Collier, 70, Market-street, Manchester.

18771. **Improvements in electric railway brakes.** Henri Pieper, Fils, 47, Lincoln's-inn-fields, London.

18775. **Improvements in electric bell indicators.** Siemens Bros. and Co., Limited, George Sylvester Grimston, and Ernest Perrett, 28, Southampton-buildings, London.

October 31.

18784. **Improvements in electrical measuring instruments, dynamo-electric machines, registering instruments, and transformer switches.** James Swinburne and Walter Fox-Bourne, Broom Hall Works, Teddington, Middlesex.

18801. **Improvements in electric arc lamps** Thomas Henry Smith, 2, East-parade, Leeds.

18834. **A novel application of electricity to domestic purposes.** Alexander Howlinson and Walter James Nelson, 17, St. Ann's-square, Manchester.

18837. **Improved means for supporting overhead electrical conductors round curves for electric railways or tramways.** Siemens Bros. and Co., Limited, Southampton-buildings, London. (Siemens and Halske, Germany.)

SPECIFICATIONS PUBLISHED.

1890.

15777. **Electric meters.** Mills. (Blein). 8d.
16821. **Producing light by incandescence.** Heskin. 8d.
17266. **Electric railways.** Fell. (Richter.) 8d.
17558. **Testing electric wires.** Rathbone. 6d.
17829. **Incandescent lampholders.** Charnock. (Charnock.) 8d.
17851. **Electric fire, etc., indicating apparatus.** Binko. 8d.
18206. **Dynamo-electric generators, etc.** Davis and Stokes. 11d.
20043. **Telephones and mechanical signals.** Anders and Elliott. 8d.

1891.

3404. **Telephone switches** Elliott and Furtado. 8d.
12898. **Electric deposition of copper.** Parker. 8d.
13627. **Electric current motor.** Brain and Arnot. 8d.
13936. **Electric motors.** Kinter. 8d.
14234. **Electric railways.** Cattori. 8d.
14378. **Arc light carbons.** Garland. 8d.
14962. **Telephones.** Brown. 6d.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Brush Co.	—	3⅝
— Pref.	—	2⅜
India Rubber, Gutta Percha & Telegraph Co.	10	19½
House-to-House	5	5
Metropolitan Electric Supply	—	10⅛
London Electric Supply	5	2⅛
Swan United	3¾	5⅜
St. James'	—	8⅜
National Telephone	5	4⅜
Electric Construction	10	6⅛
Westminster Electric	—	6⅛
Liverpool Electric Supply	5 3	6⅛ 2⅛

NOTES.

Durban is to be lighted by electric light on the Thomson-Houston system.

Edison's Patents.—In a recent interview, Edison says he has never made anything out of his European patents.

Institution Dinner.—The annual dinner of the Institution of Electrical Engineers takes place to-night at the Criterion Restaurant at 7 p.m.

Lubrication.—We have received a neat pamphlet on "Lubrication—Oil to Save Power" from the Vacuum Oil Company, The Albany, Liverpool.

Spanish Technical Review.—We are in receipt of the *Revista Tecnologico Industrial*, the monthly publication of the Association of Industrial Engineers of Barcelona.

Electric Printing.—The presses upon which the *Western Electrician* is printed are now run by electricity. A 25-h.p. Edison electric motor is used, current being supplied from the Chicago Edison Company.

New Business.—We hear that Mr. George North has resigned his appointment with Woodhouse and Rawson United, Limited, in order to commence business on his own account at 90, Queen-street, E.C.

Paddington.—The Paddington Vestry has decided to accept the offer of the Metropolitan Electric Light Company to supply all buildings in Paddington with electric energy at 7d. per Board of Trade unit.

Ferranti Mains.—The firm alluded to last week as putting down plant to manufacture Ferranti mains is the British Insulated Wire Company, Prescot, Lancashire, who have purchased rights for manufacture and sale.

Cork Asylum.—At the meeting of the directors of the Cork District Lunatic Asylum, the estimate of an English firm for lighting the new building by electricity was read, but on account of expense it was decided to use gas.

Persia.—It is stated that a syndicate of Belgian financiers have obtained a concession from the Persian Government of the monopoly of electric lighting in Persia. The office of the company will probably be at Brussels.

Society of Arts.—The first ordinary meeting of the Society of Arts will take place on Wednesday, 18th inst., at 8 p.m., when the opening address will be delivered by the Attorney-General (Sir Richard Webster, M.P.), chairman of the council.

Electric Railways.—Edison considers three stationary generating engines of 10,000 h.p. each will be required to run the whole of the Pennsylvania railroad system as projected. Mr. Villard will soon have a track for demonstration ready near New York.

Pullman Electric Cars.—The Pullman Palace Car Company have recently built an immense and palatial double-deck electric car, driven by two 25-h.p. Westinghouse single-reduction motors The West End Railway, of Boston, has ordered four of these cars.

Explosion at Hastings.—Trouble was experienced at Hastings by an explosion supposed to be caused by leaky gas collecting in the junction-boxes of the underground mains. The fuse went, and the lamps on the sea front were extinguished temporarily, but no personal damage was done.

Partick (N.B.).—At the meeting of the Partick Town Commissioners on Monday a letter was read from Mr. Cook, electrical engineer, recommending the Commissioners to apply to the Board of Trade for a provisional order for electric lighting, and the matter was referred to a committee for consideration.

Mutual Telephone Company, Limited.—Seven hundred and fifty subscribers to this company's Manchester exchange are now connected. The company has 38 private wires also completed. On October 31 they possessed in Manchester 154 standards, 76 poles, 190 cables, 209 distributing-boxes, 1,050 miles of wire, and attachments to 720 buildings.

Telephoning between Lincoln and Liverpool.—The telephonic communication was established on Thursday last week between Lincoln and Liverpool. The Mayor of Lincoln spoke through to the Mayor of Liverpool, and offered him his congratulations on the success of the enterprise. The congratulations were mutual, and each voice could be distinctly heard.

New French Electrical Review.—Another technical electrical journal is stated to be in contemplation in Paris, the *Revue de l'Electricité*. France is well off for electrical journals; although gas has only five, the science and practice of electricity has already eight technical papers, and the above will make a ninth—a striking comment on the activity of electrical science.

The Electricity Act in Burmah.—It is officially notified, says the *Indian Engineer*, that in exercise of the power conferred by Section 5 of the Scheduled Districts Act, and with the previous sanction of the Governor-General in Council, the Chief Commissioner of Burmah is pleased to extend the Electricity Act (XIII. of 1887) to Upper Burmah, except the Shan States.

Deptford.—We are sorry, though perhaps not altogether surprised, to hear that a serious breakdown has taken place in the mechanical arrangements of the Deptford central station. We can only think that it is an extreme pity that the directors and Mr. Ferranti have thought well to entirely sever their connection until the station was more in thorough working condition.

Huddersfield.—The Corporation of Huddersfield are about to erect an electric lighting station and plant, and to lay mains in connection therewith, and are prepared to receive applications from electrical engineers competent and willing to superintend the execution of the works, the contractors for which are the Brush Electrical Engineering Company, Limited. Particulars of application may be seen in the advertisement columns.

Hammersmith.—The Hammersmith Vestry has decided to refer to their Electric Lighting Committee the question of electric lighting in the district. The committee will consider the draft provisional order and map of the proposed area of supply by the Putney and Hammersmith Electric Light and Power Supply Company, and a special meeting of the Vestry will be held on December 9th to consider the report of this committee.

Royal Meteorological Society.—At the meeting of this society to be held at 25, Great George-street, Westminster, on Wednesday, the 18th inst., at 7 p.m., the following papers will be read: "Report on the International Meteorological Conference at Munich, September, 1891," by Robert H. Scott, M.A., F.R.S.; "Results of Meteorological Observations made at Akassa, Niger Territories, May, 1889, to December, 1890," by Frank Russell, F.R.M.S.

Liverpool.—The second largest installation of electric lighting in Liverpool has been put in University House, the clothing manufactory of Messrs. Henechsberg and Ellis, by Messrs. A. Hall and Co., of that city. The shop is lighted by 140 glow lamps, the windows are fitted with electroliers and shell lights, and the turret is surmounted by a 20-ampere arc lamp which is visible as far away as the Welsh mountains, and will form a new beacon light for mariners entering the Mersey.

Hammerfest.—The most northerly town in all Europe, Hammerfest, is lighted by electric light down to the smallest house. The lighting is an important question in these latitudes, where the sun does not rise at all from the 18th November to January the 23rd. On the other hand, during three months of the year the sun does not set at all. The light is, of course, most required during the coldest months, and the power is supplied by turbines from three streams, which are sufficiently rapid not to become frozen even in their winter.

Chicago Exhibition.—The large structure in the World's Fair buildings known as Electricity Hall, says a *Dalziel* telegram from Chicago, has been declared unsafe, and the architects are debating whether they will tear up the foundations and do the work over again or endeavour to strengthen the sub-structure. The building has been so badly planned that it would, when completed, scarcely sustain its own weight, and at least 75,000dols. will be required to make it safe. All the large structures have now been condemned as unsafe. This seems a bad beginning for the famous fair.

Helston.—At the quarterly meeting of the Helston Town Council held last week a letter was read from Mr. A. Pryor, agent for Mr. J. C. Williams, giving terms offered for lighting Helston by electric light: the use of stream for the sum of £6 a year, 80 years; land required at 5s. an acre surface right only, 30 years' purchase. Mr. Winn moved the acceptance of the offer, and Mr. Benniger moved an amendment that the matter be deferred. Four voted for and four against, the Mayor giving a casting vote for the amendment, Mr. Dale challenging his right so to do. The question is therefore deferred.

Exhibition at St. Petersburg.—An international electrical exhibition is announced to be opened on 1st December, to extend to 15th March, 1892. The object is to show the Russian municipalities the various systems of electric distribution of light and power, and their particular advantages. Space has been retained by Ganz and Co., Siemens and Halske, the Continental Edison Company, and others. The tariff is 36f. per square metre (say 27s. per square foot) floor space, and 18f. for wall space. The Russian railways will reduce the transportation charges by 50 per cent. for goods addressed to this exhibition.

Cheap Fittings.—The *Gas World* has the following: "Berlin seems to be doing a brisk trade in gas fittings and electric light fittings. A curious circumstance is referred to in the Berlin Trade and Industry Annual Report. Tenders were invited for certain decorated electric light fittings in the Imperial Palace in Strassburg. Minutely detailed specifications were provided. The highest tender was £6,850; the lowest was £1,750. The matter was delayed, and an offer was received and accepted to do the whole thing for £1,250. The gilding provided for by the specification would alone have cost £1,200 or more!"

Telephone from Sheffield to Lincoln.—The National Telephone Company opened a trunk line on Monday from Sheffield to Lincoln. The Mayor of Sheffield congratulated the Mayor and inhabitants of Lincoln on being able to converse together, and said he had no doubt that the new line would prove of great advantage to the people of both places. The Mayor of Lincoln reciprocated the congratulations. Telephonic communications have now been established between Sheffield and Middlesbrough, Sunderland, Newcastle, and other north-eastern towns, and these wires will be formally opened in the course of a few days.

Electric Light Cables.—Mr. Stuart A. Russell's new work on "Electric Light Cables and the Distribution of Electricity" will be issued shortly in Messrs. Whittaker's "Specialists' Series." The work, after considering the laws relating to temperature and pressure, and the effect that they have on the determination of the sectional area of the conductor, goes on to describe the various methods of insulating. Chapters follow on the testing of cables, on external wiring, underground work, and the methods of distribution of our various supply companies; to which are added notes on testing circuits in daily use, and on the localising of faults in conductors.

Junior Engineering Society.—The election is announced of Sir E. J. Reed, K.C.B., F.R.S., M.P., to the presidency of the Junior Engineering Society, the eleventh session of which is to be inaugurated on the 27th inst. by the delivery of his presidential address. A visit of this society will take place on Saturday, 14th inst., at 3.30 p.m., to the Royal Institution Laboratories, Albemarle-street, through the kindness of Lord Rayleigh and Prof. Dewar. The institution contains a unique collection of the original apparatus used by Davy, Faraday, and other early experimenters. Demonstrations in the laboratory and lecture theatre will be conducted on the occasion of the visit.

Physical Society.—A meeting of the Physical Society was held on 6th inst., Dr. E. Atkinson, vice-president, in the chair. Prof. Sydney Young, D.Sc., read a paper on "The Generalisations of Van der Waals regarding Corresponding Temperatures, Pressures, and Volumes." Experiments had been made on benzine and its halogen derivatives, and on the alcohols. In the discussion, Mr. Blakesley, in speaking of molecular forces, said he had observed that when water is allowed to evaporate from glass, a furrow is formed in the glass, which marks out the original boundary of the liquid. To all appearance, the particles of glass are torn away by the molecular forces acting along the boundary.

Leicester Co-operative Boot Factory.—The largest co operative boot and shoe factory in Leicester has just been opened. The factory stands on a site of six acres, leaving ample room for extension. It is three storeys in height, is 100 yards long, and 90 yards wide, and the rooms are not only spacious, but admirably constructed as regards light and ventilation. The buildings cost £30,000, and when fitted with machinery, the total outlay will amount to £50,000, while £200,000 capital will be required to work the concern. Two engines of 150 h.p. will drive the dynamos for the electric light and supply the motive power. About 1,500 workpeople will be employed at the start, and the factory will produce about 50,000 pairs of boots per week.

Fluorine.—M. Moisson four years ago succeeded in isolating the gaseous element fluorine, and has since published researches upon its nature. Its colour in mass is greenish-yellow, and its intense chemical activity render experiments dangerous. Nitrogen and chlorine are not reacted upon, and graphite only at dull heat, but nearly everything else is fiercely attacked. Silicon even becomes white hot in its presence at a temperature superior to its fusing point. The idea is expressed that with such an agent, when its production is easier, high-temperature fires and smelting furnaces would be replaced; and as if ever electricity is produced direct from heat economically it will probably be by means of very high temperatures, the researches upon fluorine may also lead to useful results in this direction.

Crystal Palace Electrical Exhibition.—A meeting of the Honorary Council of Advice and of a special committee appointed by the Electrical Section of the London Chamber of Commerce, will, by kind permission of the Lord Mayor, be held at the Mansion House, at three o'clock on Wednesday, the 25th inst., when a report on the progress of the exhibition will be presented, and the question of how the exhibition may best be used as a means of advancing the interests of electrical science will be considered. The Lord Mayor will preside. The whole of the space is now practically allotted, extra buildings having been erected for certain large installations which could not otherwise have been accommodated.

Berlin Electric Railways.—The Allgemeine Electricitäts Gesellschaft, not to be outdone by Siemens and Halske, who propose overhead electric railways, have applied for a concession to build an underground electric railway in Berlin, 30ft. below the surface. Iron tubes are to be used, as in the South London railway, and trains of a locomotive and three cars would be run on a three minutes' service. The line will run right through the city from north to south and east to west, also a circle railway to connect the four termini. The fare from station to station, third class, is to be one penny. This great improvement in Berlin urban traffic accommodation, it is stated, is to be commenced at once, and will be ready long before the first rail of the oft-deferred Vienna Metropolitan Railway has been laid. The line from running north and south, first to be constructed, will cost £600,000.

Electric Gas-Leak Detector.—A system likely to be of use in large establishments where gas is the illuminating agent is described in the *Revue Industrielle*, October 31, the invention of M. Exupère. In principle it is similar to an aneroid barometer, having a vacuum chamber working a contact-piece. When the meter is turned out the tap of this instrument is turned on, the pressure of gas dilating the diaphragm. The time which expires until electric contract is made by means of a lever arm attached to the diaphragm is a measure of the extent of the leak—the shorter the time, the greater the leak. The instrument might be of great utility in large houses or factories, and is an interesting example of the application of electricity to gas lighting to reduce the danger and expense of the latter, though, on the whole, the best way to do this would be to introduce electric lighting at once.

Manchester Geological Society.--The address ot the President of the Manchester Geological Society on the prospects of coal-mining pointed out that while the colliers are calling for shorter hours, the upper seams are getting rapidly worked out, and the time is approaching when we must go deeper down into the earth. This will necessitate a greater average depth of workings, in which the heat and pressure will be greater, with probably more dust. This will require larger volumes of fresh air, stronger timber props, improved means of laying dust, and better methods of lighting, getting, and hauling the coal, all of which of course means heavier expenditure. In lighting, electricity is expected by the president to play an important part; and as what is most needed is a satisfactory mechanical coalcutter—a description which cannot be applied to the machines of this kind already in use—electricity may also be expected to aid also in this direction. Coal-mining may evidently become eventually simply a branch of electrical engineering.

The Royal Society.—The following is the list of names recommended by the President and Council of the Royal Society for election into the council for the year 1892 at the forthcoming anniversary meeting on November 30: President: Sir William Thomson, D.C.L., LL.D. Treasurer: John Evans, D.C.L., LL.D. Secretaries: Prof. Michael Foster, M.A., M.D., the Lord Rayleigh, M.A., D.C.L. Foreign Secretary: Sir Archibald Geikie, LL.D. Other members of the Council: Captain William de Wiveleslie Abney, C.B., William Thomas Blanford, F.G.S., Prof. Alexander Crum Brown, D.Sc., Prof. George Carey Foster, B.A., James Whitbread Lea Glaisher, D.Sc., Frederick Ducane Godman, F.L.S., John Hopkinson, D.Sc., Prof. George Downing Liveing, M.A., Prof. Joseph Norman Lockyer, F.R.A.S., Prof. Arthur Milnes Marshall, D.Sc., Philip Henry Pye-Smith, M.D., William Chandler Roberts-Austen, F.C.S., Prof. Edward Albert Schäfer, M.R.C.S., Sir George Gabriel Stokes, Bart., M.A., Prof. Sydney Howard Vines, M.A., General James Thomas Walker, C.B.

Shiplighting.—The Aberdeen liner "Thermopylæ," which has just arrived in the Thames from the yard of Messrs. Hall, Russell, and Co., Aberdeen, belongs to Messrs. George Thompson and Co., Aberdeen and London, and is intended for the Australian trade. Her dimensions over all are—length 380ft., breadth 44ft. 6in., depth 34ft., and her gross registered tonnage is about 4,000. When fully laden she will carry a dead weight of about 5,000 tons, and is designed for a speed of 14 knots per hour. The "Thermopylæ" is built entirely of steel, and is one of the best equipped ships for passenger service. The vessel is lighted throughout by electricity, installed by Messrs. Holmes and Co., Newcastle and London. There are 142 16-c.p. lamps for the state rooms, etc., one 50-c.p. lamp for the engine-room, and four 200-candle Sunbeam lamps for the holds. The "Thermopylæ" is commanded by Captain Alexander Simpson, late of the ss. "Australasian." Mr. Robert S. Mackie, late of the ss. "Damascus," will be the chief engineer. She sails for Sydney and Melbourne on the 24th inst.

Gas Engine Stations for Leicester.—Mr. Lennard, the chairman of the Leicester Corporation Gas Committee, at a recent visit of the members of the Town Council to the gas works, referred to the provisional order for Leicester, which would shortly have to be put in force. In 1888 they had received this order, and it was remarkable that only one local body in London, the St. Pancras Vestry, had ventured to apply for rights. The experiment of this body was very similar to that about to be made in Leicester. Several applications had been received by the Council from companies who were willing to take over the order; but he was of opinion the Corporation gas department should take the matter up themselves. It seemed to him they ought to set about taking advantage of the order at once. He went on to say that he was afraid they would not make the undertaking pay if they used steam engines, and he was prepared to recommend the Corporation to use gas engines, which would cost less for plant, fuel, and labour. They proposed to have stations in several parts of the town, and not distribute over a radius more than a quarter of a mile. In this way he was not afraid that the gas interests would be damaged.

Bombay.—The following seems to be the state of the electric lighting question in Bombay: The Municipal Commissioner of Bombay, Mr. Ollivant, decided to invite tenders for lighting certain portions of the city for an experimental period not exceeding two years. A number of tenders were received; none of them were deemed satisfactory, the period being too restricted to encourage terms to put down costly plant at their own expense. The subject remained in abeyance until the present municipal commissioner, Mr. Acworth, made a fresh application for tenders some seven or eight months ago, and to which some three or four firms responded. Specifications and proposals were asked for lighting within the Budget grant of 60,000 rupees as much as possible of the road from the Arthur Crawford Market along the Esplanade-road to the Apollo Bunder. Mr. Acworth placed the tenders before the Standing Committee for consideration. A majority were of opinion that the time had not yet arrived when the Corporation should be recommended to spend a sufficient sum of money for carrying out the experiments proposed, as it was found they could not be undertaken by any firm within the small Budget grant, which would not cover the cost of expensive plant. It is to be hoped that the proposal will not be allowed to be dropped.

London County Council and the Meters.—The London County Council are taken sharply to task by Mr. G. B. Hemming, who writes from Earl's Court-square to the *Times* with reference to the difficulty in obtaining tested meters. It is only fair to say that having been left by their specialist they have had to appoint another—an appointment only just carried out. Mr. Hemming's letter is as follows: "Sir,—Much as I may admire the high policy of the County Council, I cannot help thinking that they are a little remiss in the performance of their workaday duties. One of these is to protect the public by testing and certifying the accuracy of the meters supplied by electric supply companies. I am informed by one of these companies who ought to be supplying me with light that they have had 100 meters in the hands of the County Council for six or seven months, and cannot get them back, and that they do not know how much longer I may have to wait before they can put in a meter. As I have already lived nearly two months with my gas put out and nothing to replace it, I think I may fairly complain of the County Council for neglect of duty; and as my case is only one of a multitude of like instances it does seem that the County Council are wantonly inflicting a grievous inconvenience upon a large number of the constituents whom they tax so freely. If you will kindly insert this letter it may perhaps induce them to moderate their policy of neglect."

Chislehurst.—In accordance with a resolution passed at their last meeting, the Chislehurst Committee of the Bromley Rural Sanitary Authority on Monday received a deputation from the Provincial Electric Lighting and Supply Company, the deputation consisting of Captain Simpkins, manager; Mr. Inglis, secretary; and Mr. Smee, solicitor. Mr. Smee said the company proposed to obtain powers for lighting the parish of Chislehurst, but it must not be understood that it was the intention of the company to confine themselves to that only. There would be an effort to employ local capital in the scheme, and to put one or two local gentlemen on the Board. The company had not undertaken to light any other places with electricity as yet, and the reason they had selected Chislehurst was that Mr. Willett, who had erected a large number of houses on the Camden estate, proposed "wiring" every house on to an electric supply, and, instead of gas, providing only the electric light. Mr. Willett had approached the company, and it was thought that this would be a capital opportunity of introducing the electric light to the whole parish. The company had taken into consideration the various methods for distribution of electric current, and they would adopt the low-tension system as the safest, and also as possessing other advantages, besides being recommended by the Board of Trade. It would be quite optional with the residents whether they adopted the light for private or public purposes. At the end of 40 or 42 years the company would be compelled to sell, but in all probability they would be doing so before that time. The present capital was a merely nominal one of £1,000, it being desirable before inviting capital to see whether the local authorities' consent could be obtained, in which event the company would then readily find the requisite capital. It was resolved to defer any discussion until the publication of notices and plans by the company, which must be published this month.

Water Power in Switzerland.—The project for the conversion of the use of water power in Switzerland is creating a great amount of interest in that country. The *Journal de Genève* recently reviewed the circumstances which have led to the evolution of such a scheme. First amongst these are the prevalence of "deplorable strikes," more particularly in the coal trade, manufacturers being greatly embarrassed by failure of supplies. The uneasiness which these disturbances have caused has stimulated the hope of being able to dispense with coal in Swiss industrial undertakings altogether. The invention of the turbine as a substitute for the antiquated waterwheel, and the successive improvements which have been made in it, with the success of the installations at Schaffhausen, Zurich, Berne, Fribourg, Geneva, and Bellegarde, for utilising the water power of the Rhine, Limmat, Aar, Sarine, and the Rhône, have also promoted the idea by demonstrating that really immense power can be obtained from the comparatively slight falls of great rivers when approaching the plains. Installations to utilise this power would, however, have to be on such an immense scale that they would only be possible by means of large joint-stock companies, and this usually only for the towns. The use of turbines utilising small streams of great fall offers a further solution of the difficulty, great power having been obtained from tiny streams descending 1,500ft. through suitable pipes. But such falls being situated far from industrial centres are only utilisable by means of electric transmission of power, the belief in the feasibility of which has received so great an impetus from the Frankfort Exhibition. It is evident that the complete utilisation of these water powers would mean a network as intricate as a railway or telegraph system, and the State monopoly is thought to be the best solution. Many questions of private and cantonal rights will first have to be settled before the scheme can come to the point of achievement.

Civil Engineers.—The opening meeting of the Institution of Civil Engineers was held on Tuesday, when the president, Mr. George Berkley, delivered his inaugural address. The address was occupied by the review of the progress of civil engineering generally. Reference was made to the proposed utilisation of the water power from the Niagara Falls, for which a company had been formed in 1886 and a charter had been secured. The progress in telegraphy, telephony, and electric lighting and power was next dealt with, and the experience acquired by the authorities of the General Post Office was cited. It appeared that by the multiplex system of working six messages could be sent along a single wire instantaneously in each direction; the length of conducting wires laid in England for public telegraphic purposes was 174,633 miles, and the number of instruments was 13,740. In London 5¾ million messages, and in Great Britain 66½ million messages were received in 1890. Speech had been maintained with perfect clearness by telephone between London and Paris, a distance of 311 miles. The electric transmission of power was then noticed, especially the transformation of electric into mechanical energy, by making the dynamo serve as a power-receiving as well as a power-giving machine. Since 1883 the usefulness of the dynamo and motor had been further developed, chiefly by the means taken to reduce losses of energy by friction and by eddy-currents and magnetic leakage, as well as to avoid sparking. For the illumination of streets in this country electric light must hereafter become more general. The length of electric rail or tramways worked in England only extend to 26½ miles, its most perfect application being, perhaps, that of the City and South London Railway. Another use of electricity was the connection of many parts of the world by submarine cables, of which 48,600 miles had been laid. Electricity had been successfully applied to lighting, haulage, drilling, and coal-cutting, in mines, both in England and America, and for welding metals—a process which was steadily on the increase.

Official Inspection of Roundhay Tramway.—The Roundhay-road electric tramways, which were formally opened a fortnight ago, were officially inspected on Monday afternoon by Major-General Hutchinson, inspector of the Board of Trade, and Major Cardew, R.E., electrical engineer to the Board. Under the guidance of Mr. I. E. Winslow, manager of the electric tramways, the Board of Trade representatives first visited the sheds in Harehills-lane, and made a minute examination of the appliances connected with the propulsion of the cars by the Thomson-Houston system. They were then taken in one of the half-dozen admirably-appointed cars over the whole length of the lines which it is intended to work by electricity, first proceeding to the terminus at the new entrance to Roundhay Park, then returning along Roundhay-road to Sheepscar, and subsequently passing over the Beckett-street section. At different points on the route experiments were made with the object of testing the capabilities of the cars in regard to speed, brake power, and other qualities, and in every instance the results appeared to be quite satisfactory. The inspectors will make their report in due course, but in the meantime they have given permission for the running of the cars on all the lines with the exception of the Beckett-street section, the use of which cannot be sanctioned until the space between the metals had been slightly increased. Mr. Winslow states that the public will be able to avail themselves of the cars between Sheepscar and Roundhay this week. To begin with, the cars will leave each terminus every quarter of an hour, but it is intended, as necessity arises, to run them at shorter intervals. The Leeds Corporation was represented at the inspection by Alderman Firth, chairman of the Highways Committee, and Mr. Prince, of the Highways Department. A later report says: On Wednesday the Roundhay-road and Beckett-street lines were opened for public traffic. The first cars left Sheepscar at 11.30 a.m., and the Beckett-street terminus at 11.35. The cars were run every quarter of an hour, and the novelty of electricity as the motive power caused much interest to be taken in their movements.

Variation of E.M.F. under Pressure.—From the theories of Helmholtz upon free energy, M. Henri Gilbault, in the *Comptes Rendus*, derives the formula $q \frac{dE}{dp} = dv$, in which E indicates the E.M.F. of an element, q as the quantity of electricity which is developed when, in consequence of the reaction, a variation of volume, v, is produced; p represents the atmospheric pressure. This formula enabling the variation of E.M.F. under pressure to be calculated, it is not difficult to verify the theory by direct experiment. This is what M. Gilbault has done, and he gives the results observed. Operating upon batteries exempt from disengagement of gas, the variation of E.M.F. is expressed by $E_0 - E = ap - bp^2$, b being an infinitely small quantity, only being of importance at high pressures: therefore for these cells at moderate pressures the variation of E.M.F. with pressure is linear, which accords with theory. In tests upon cells which give off gas, it was found that the variation of E.M.F. may be expressed in function of the pressure by the formula $E_0 - E = A\,Lp - cp$, c being again very small, which it as much as to say that for moderate pressures the variation of E.M.F. takes place following a logarithmic curve, as indicated by the first formula. The accord of theory with practice is strikingly shown in the following table, which gives the variations of E.M.F. of the different cells expressed in ten-thousandths of a volt for a variation of pressure of 100 atmospheres:

Cell.	Variations in 10,000ths of volt.	
	Calculated.	Observed.
Daniell (20 per cent. SO_4Zn	+ 5·17	+ 5
do. (27·56 per cent. SO_4Zn)	+ 2·2	+ 2
De la Rue (1 per cent. ZnCl)	+ 6·62	+ 7
do. (40 per cent. ZnCl)	– 5·04	– 5
Planté accumulator (8·8 p. c. SO_4H).	– 12·7	– 12
Volta	– 586	– 600
Bunsen	– 383	– 405
Gas battery	+ 865	+ 845

M. Gilbault thinks he is justified in concluding perfect agreement between the theory of Helmholtz and practice for small pressures, though for higher pressures secondary effects might possibly be superadded.

Simultaneous Telegraphy and Telephony.—The problem of achieving the transmission of telegraphic and telephonic messages along the same line has been attacked by M. van Rysselberghe with questionable success, and more recently Mr. Langdon-Davies in his phonophore has attempted it in an entirely different manner, using telephonic currents to actuate a relay for working a specially-constructed Morse instrument. A third inventor is now in the field in France, M. Pierre Picard, who has achieved successful results with simultaneous telephony and telegraphy. For the Picard system double metallic circuits are required. At each urban station a "differential transformer" is inserted in the circuits, composed of four parallel coils equal in length and resistance, which may be distinguished as 1, 2, 3, 4. The winding of 1 is connected in series with one of the telegraph lines; the exit end of 2 is connected to the entrance end of 1, and its entrance end to the exit end of 1. The second telegraph line is connected to the exit end of 2. From this point the two line wires are connected together on one wire. The telegraphic current therefore passes in contrary directions in 1 and 2; such a system has no inductive influence. Coils 3 and 4 are connected, the exit of 3 to the entrance end of 4, and the two other ends to the telephone wire. The transmission of a telegram does not affect 3 and 4, and the telephone is silent. But if the telephone is used coils 3 and 4 are the seat of a current both in the same direction, and an induced current is generated in 1 and 2. This current is propagated along the telegraph wire, but in inverse direction along each of the double wires. A similar differential transformer at the receiving end is the seat of an induced current, which excites the telephone. The system is therefore extremely simple, but it requires two lines of similar capacity—an essential condition only occasionally realised on telegraphic lines. In trials between Paris, Lyons, and Marseilles simple insertion of the transformers permitted the simultaneous exchange of telegraph and telephone messages. Between Paris and Troyes one line was an old wire and the other a new one, and the capacities differed considerably, with the consequence that noises in the telephone rendered hearing impossible, but by making the capacity artificially equal perfect results were attained. The Picard system allows the Baudot telegraph receivers to be used, which the Rysselberghe system does not, and the efficiency of the line is therefore doubled.

UNDERGROUND MAINS.—X.

THE ST. PANCRAS MAINS.

The underground electric light mains used in the central station of the St. Pancras Vestry are laid upon the three-wire system of bare copper strip upon earthenware insulators in culverts, according to very careful designs prepared by Prof. Henry Robinson, C.E., consulting engineer to the Vestry. The mains are constructed so far as regards the insulators and conductors by Messrs. Latimer Clark, Muirhead, and Co., Regency-street, Westminster, the concrete culverts being laid by Messrs. Mowlem and Co.

The whole of the details for these mains have been carefully carried out to drawings and laid under the personal supervision of Prof. Robinson and his assistants, together with Mr. Thornton, manager to Messrs. Clark, Muirhead, and Co., and his assistants, and embody a very thorough and efficient distributing system, great care having been taken to adjust the size of mains to the probable demand, and to provide for efficient draining and the prevention of electrical leakage by reason of damp.

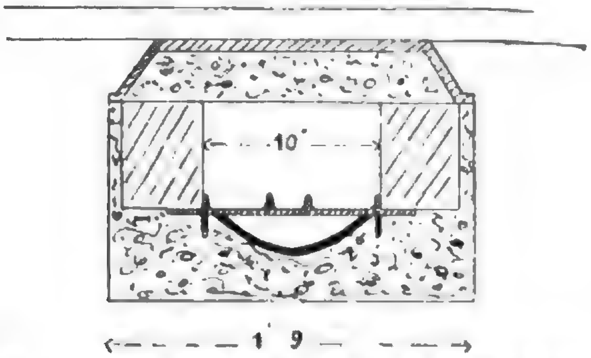


Fig. 1.—10in. Conduit, for One Set Underground Mains.

In principle the St. Pancras mains consist of bare strips of copper carried edgewise upon earthenware insulators of special shape, these insulators being themselves supported and kept in place by being slipped upon studs which project from cast-iron cross-bars or brackets, built in at intervals along brick and concrete culverts. This is the kind of main mostly used, but in practice it is found necessary to employ both a culvert system and a pipe system, the latter being used when room is scarce. In this case the mains are made up of the same copper strips and earthenware insulators tightly bound together, and drawn in solid as a complete set of mains into iron pipes.

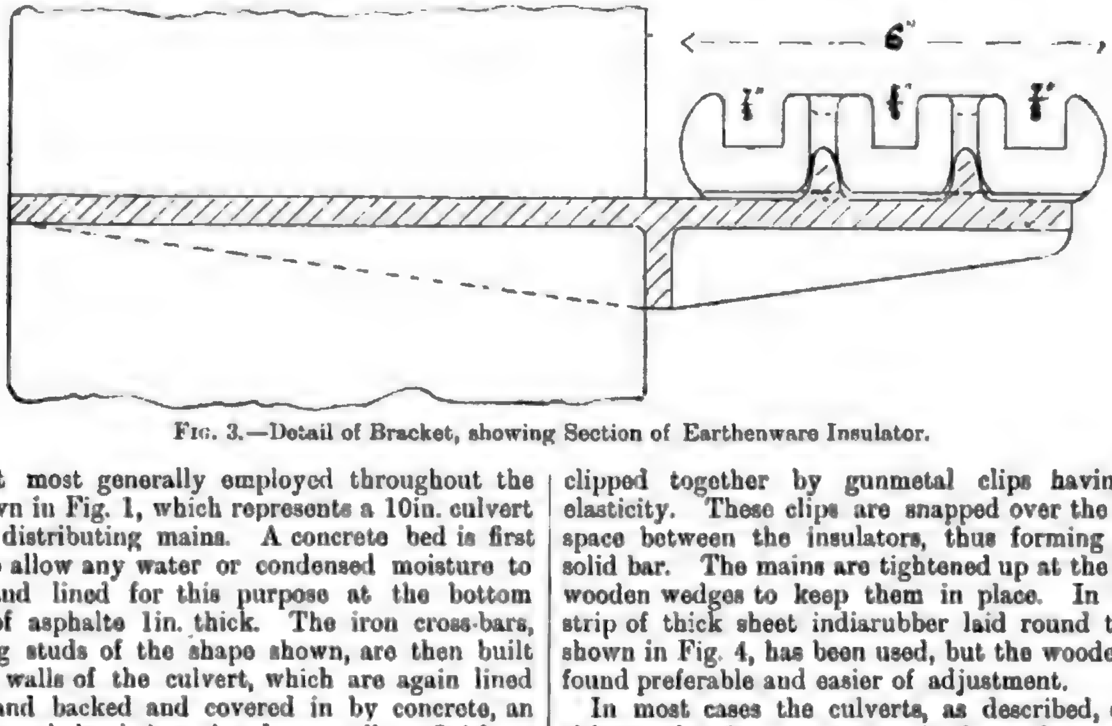


Fig. 3.—Detail of Bracket, showing Section of Earthenware Insulator.

The culvert most generally employed throughout the district is shown in Fig. 1, which represents a 10in. culvert for one set of distributing mains. A concrete bed is first laid, sloped to allow any water or condensed moisture to drain away and lined for this purpose at the bottom with a layer of asphalte 1in. thick. The iron cross-bars, with projecting studs of the shape shown, are then built into the brick walls of the culvert, which are again lined with cement and backed and covered in by concrete, an upper layer of asphalte being placed over all as finish to prevent moisture percolating through. This culvert is used when laid under the pavement, and the flagstones come down upon the roof of the culvert.

A larger culvert, as used under roadways, is shown in Fig. 2. This is an 18in. culvert for two sets of mains side by side, or one set each of mains and feeders; and in many cases a third set is also run above the others upon brackets having similar projecting studs, built into the wall as shown. The detail of this bracket and also of the earthenware insulators is shown in Fig. 3. Each insulator has three rectangular grooves to receive the three sets of copper strips, and is also pierced from below by two taper holes, which fit upon the projecting studs of the iron brackets or cross-bars, the weight of the mains being amply sufficient to keep the whole in place. The culvert is constructed, as before described, of brick and concrete with an upper layer of asphalte, the earth of the roadway coming above this. Iron pipes are laid alongside the culverts, as shown in cases where the series arc lighting is to be carried out, for the reception of the high-pressure mains. Junction-boxes and drawing-in boxes are inserted in the pavement or roadway at intervals, fitted with watertight lids filled in with slabs of concrete on their upper surface, or roughened to give foothold. The culverts are always widened out at each junction-box to allow room for connecting up and handling the copper strip.

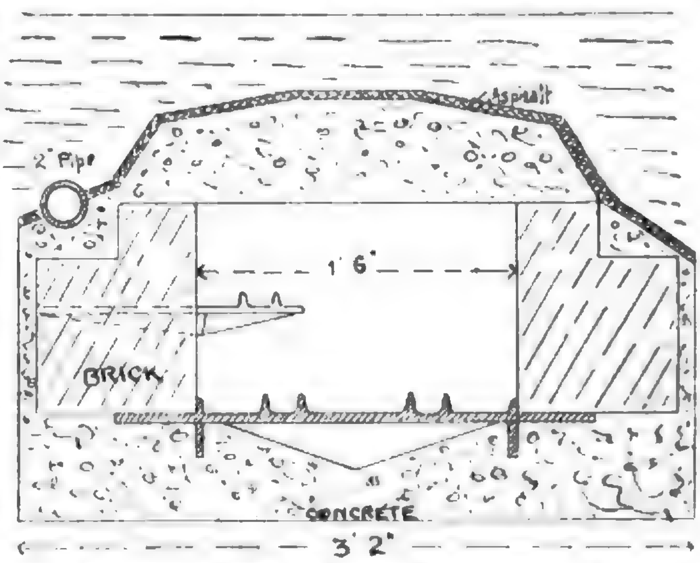


Fig. 2.—18in. Conduit, for Three Sets Underground Mains.

The strips of copper are joined end to end, being carefully cleaned and riveted with a lap-joint, then straightened and laid or drawn in, and strained to lie straight in their slots. Each main consists of several strips, which are clipped together by gunmetal clips having a certain elasticity. These clips are snapped over the strips in the space between the insulators, thus forming practically a solid bar. The mains are tightened up at the insulators by wooden wedges to keep them in place. In some cases a strip of thick sheet indiarubber laid round the copper, as shown in Fig. 4, has been used, but the wooden wedges are found preferable and easier of adjustment.

In most cases the culverts, as described, can be used, either under the pavement or in the roadway, without more trouble in arrangement than the occasional shifting of a gas or water pipe. Whenever possible, these pipes, if passing across the line of culvert, are raised or lowered a little to come either above or below the level of the culvert. In cases where this is not possible, and the roadway is too crowded to allow a culvert, the mains are laid in iron pipes. An 8in. cast-iron pipe is first laid, and the mains are then made up, with all the insulators in place and bound tightly together with binding wire over wood blocks shaped to the size of the pipe, and the whole is then drawn bodily into the pipe, as shown in Fig. 5.

Large junction-boxes or four-way crossing junctions are inserted at cross-roads, where required, with gunmetal bridges screwed upon the copper strips to connect feeders and distributing mains.

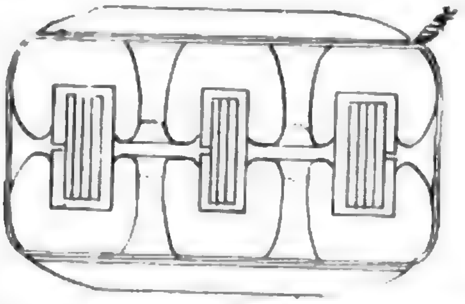


Fig. 4.—Set of Mains, with Insulators for Drawing in.

The system of mains employed at St. Pancras embraces the use of a dry air blast, forced through the culverts by means of a powerful air-compressor pump and engine at the station. This air is heated, compressed, and forced into the culverts, keeping the interior of culverts and the surface of the insulators free from any deposit of moisture. The insulation resistance is thus kept very high.

We are glad to be able to state that the demand for electric light at the St. Pancras station has already exceeded the expectations of the engineers. It was expected that the full supply of current for 10,000 lamps would be taken up within two or three years from date of starting, but from the amount of orders already received, and of houses wired for lighting, it is quite expected that the full amount of the supply will be reached during this season. Such a result cannot but give great confidence to other vestries or municipalities seeking to undertake their own supply of electric light to the district, and great credit must be accorded to Prof. Robinson for the very careful way in which every detail has been worked out.

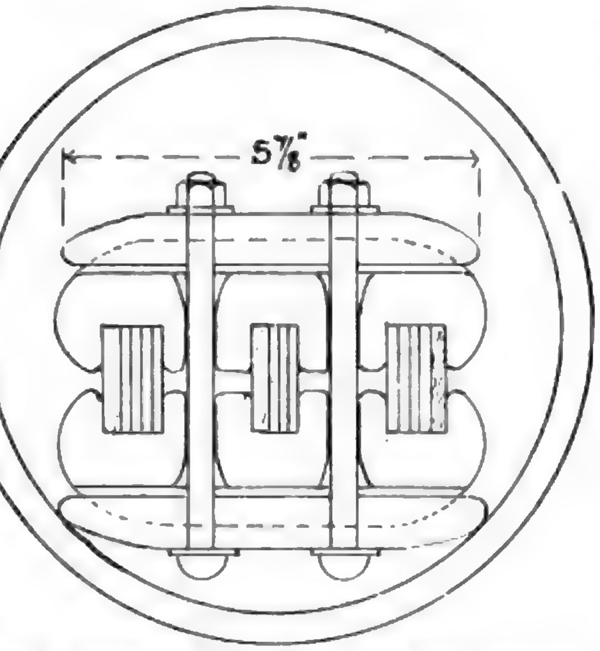


Fig. 5.—Section of 8in. Iron Pipe, with Mains Drawn in.

THE CAUSE AND NATURE OF TERRESTRIAL MAGNETISM.

BY R. C. SHETTLE, M.D.

At the present time there appears to be no satisfactory method of accounting for terrestrial magnetism—the mode in which the phenomena are evolved, or, apart from the mariner's compass, the purpose which this important and considerable form of energy has to fulfil in the economy of nature.

With regard to the cause of terrestrial magnetism, I have arrived at the conclusion that the phenomena are due to the influence which the various forms of matter exercise upon gravitational stress, whether solar, lunar, or planetary, all of which tend, or should tend, to place the axis of force in the atom in a direction which accords with the resultant of all the stresses acting upon it; and, further, that it is in this way that each atom adds its own quota in causing the axial inclination of the earth's mass, whilst the lines of magnetic force which proceed from the earth are lines of vibratory motion, which are induced by solar and other action in the ethereal atmosphere, owing to vibrations set up in the material atoms under the influence of each stress.

It should be primarily stated that all forms of matter are magnetic—*i.e.*, they exhibit, when suspended in a magnetic field of force, a particular description of polarity which is characteristic of the matter And further, that the most intimate connection exists between the magnetic, the electric, and the chemical value of an atom of matter. Thus the magnetic and the electric forms of energy are always at right angles to each other, and as the electric and chemical states are interchangeable, it is obvious that no magnetic, electric, or chemical changes can occur in an atom without a proportional change in all these three forms of energy.

It must be obvious that these forms of force are most closely associated with some great fundamental principle or law, which is more or less essential to the evolution of terrestrial phenomena in general; the more especially as all changes of temperature, or of motion from some other cause, must proportionately affect each of these forms of force and the conditions of matter which are associated therewith.

The fact cannot be too strongly insisted upon, that the chief characteristic of the magnetic force is to cause each atom of matter with which it is associated, and to which freedom of motion is permitted, to place the line of the greatest density in the atom parallel with the axis of the force. This fact alone clearly shows the intimate relations which exist between the constitution of matter and magnetic force. With the object of ascertaining the cause of terrestrial magnetism, it is desirable closely to consider the earth and the sources from which it derives its magnetic phenomena.

We find (1) that the earth is a spheroidal mass of matter permeated with ether; (2) that the earth rotates upon its axis once in every 24 hours—*i.e.*, at the rate of 1,000 miles an hour at the equator, irrespective of which the orbital motion of 68,000 miles per hour adds largely to the effects of the motion of the earth when considered in relation to the sun.

Primarily, therefore, we have to recognise a highly-porous mass of formed matter undergoing very rapid motion, permeated with ethereal matter, the precise relations of which to the formed matter with regard to motion have not yet been fully determined.

Some attempts have been matter to ascertain experimentally whether the ether undergoes the same motion as the earth, but hitherto these have met with negative results.

I shall endeavour to prove logically that relative motion must exist between the ether and the earth, and between the atoms of the mass.

The ether, according to certain of the later theories, is supposed to be condensed upon the surface of the atoms, and consequently forms an envelope for the mass as well as for the atoms. We have next to consider the earth and this ethereal envelope when subjected to its very rapid axial and orbital motions.

Perhaps the most practical method of arriving at a definite conclusion as to the influence of the motion of the earth upon the ether would be to rotate a spheroidal body in a jar of water or other fluid. Upon doing this it will be found (1) that the rotation of the sphere tends to rotate the water; (2) that the rate of motion of fluids of the same density will always be in proportion to the moving centre;

(3) that the velocity diminishes as the distance increases; (4) that the motion of the water or other fluid will diminish in proportion as the viscosity decreases, because the motion is the result of pressure and friction exerted upon the rotating body, and *vice versâ*; that is to say, the denser the medium of the surrounding fluid the greater will be its rigidity, the friction under motion between the two, and its disposition to assume the condition of the rotating centre. Inversely considered, the opposite must hold good. Consequently, the greater the tenuity, the less the rigidity and tendency to rotate; and in proportion to the tendency to remain at rest, the greater would be the *relative motion* between the two bodies.

The question then presents itself, Are there any grounds to justify the conclusion held by some, that the ether forms a perfectly rigid investiture of the earth, and of the other celestial bodies? Its highly attenuated condition seems to negative such a conclusion. Indeed, supposing that the ether forms a perfectly rigid envelope to the units of the universe, and rotates with the same speed, we have to consider, primarily, that the ethereal radius of the sun would extend not only to the circumference of the mass of the earth, but right through that body into space. The same principle must hold good with each mass in proportion to it mass and to its motion; consequently, the ethereal radius of the earth must extend to and through the sun. 2. That as the two masses are rotating axially in the same direction, friction would exist throughout the intermediate space, and the effects of this friction would be manifested (*a*) in proportion as the density of the ether increased, and it was associated with the formed matter; and (*b*) as the velocity was increased by the extent of the radius. But the friction would not extend beyond the half of any two bodies in opposition, because the direction of motion on the distant side of the two bodies would be the same. But as the ether, in the case under consideration, is rigidly connected with each atom and with the dense ether on its surface, the atomic motion set up by the motion of any two opposite bodies must be enormous, for the heat must be in proportion to the molecular motion set up by the motion of the mass of either body, in opposition to the motion of the rigid ether. The intensity of the molecular motion, under such condition of things, would appear to be sufficient to dissipate the matter composing the earth in one revolution, even if such could be performed, so that logically and physically it appears certain that the ether has a relative motion in the opposite direction to that of the moving mass, the velocity of which is in proportion to the motion of the mass, minus any little retardation caused by atomic friction.

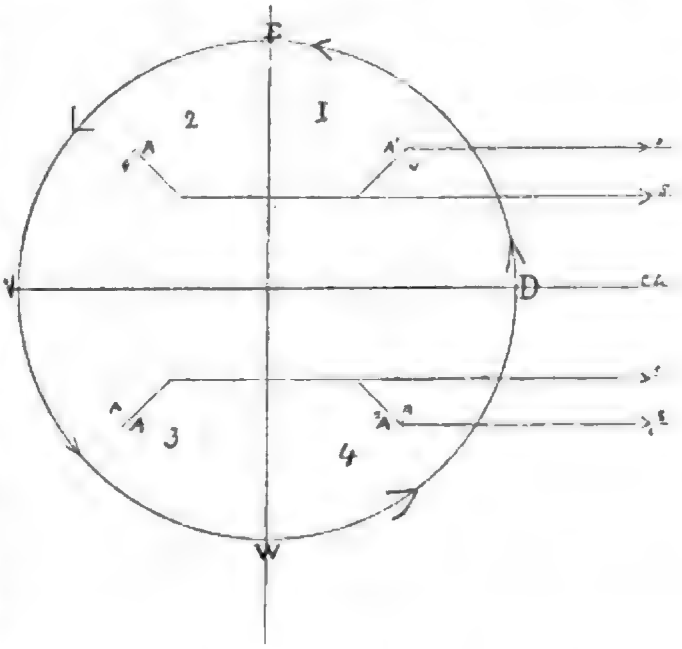
It is necessary to give some little further consideration to the probable influence which the ether and the atoms mutually exert. For instance, it is generally supposed that "the normal state of the component particles of the ether is a state of motion; second, that this motion of the particles takes place in straight lines; and third, that this motion takes place towards every possible direction."[*] Again, it is well known that all the atoms of formed matter are bi-polar, the polar phenomena varying with the character of the matter. If this be so then, whilst the general effect of the atomic motions must be to produce change in the direction of the relative motion of the ether, it is obvious that the changes must accord with the nature of the matter, and with the direction of motion. Again, the ether is, in general terms, so equally diffused over the surface of the atoms, and its relative motion is so constant, that the question arises whether this relative motion is not essential to the normal condition of the atoms. With reference to the connection which exists between the relative motion of the ether and electrical phenomena, I would venture to suggest that whilst the motion is constant and naturally diffused, it has none of the properties by which it can be recognised as static, or current electricity; but that electrical phenomena are manifested in a proportion as the quantity traversing a given area is increased by a natural or artificial cause, such as occurs under chemical action, etc. We thus recognise why every chemical change is attended with proportional changes in the magnetic and electrical conditions.

The question next arises as to the mode in which terrestrial magnetic phenomena are communicated to the ether; for it is obvious that these cannot result from the relative motion of the ether alone, because in that case there ought to exist a single magnetic pole at the seat of each geographical pole, and, as a matter of fact, it is well known that there are two magnetic poles in the northern as well as in the southern hemisphere, and that these are situated at irregular distances from the geographical poles.

For the solution of this point it will be well to examine closely the earth's motions whilst it is subject to the stress of solar and lunar gravitation, together with the influence which, logically, must result from the rapid passage of the mass in its orbital as well as axial rotation through the ether.

Perhaps the effect of solar and lunar stress is most readily determined by the influence which it exercises in the production of the tides, and therefore it is desirable very briefly to consider the theory of the tides deduced from the law of gravitation from the combined action of the sun and moon.

The tides are due, as is well known, to the attraction exercised upon the shores of the ocean by the sun and moon, either separately or combined. Near the new and full moon the flood-tide attains its maximum, whilst the corresponding low water descends to its lowest point.



The height of the tide varies with the relative positions of the sun, moon, and earth, as well as with the declinations of the sun and moon. It should also be stated that the statical equilibrium of a tidal wave is accounted for by the laws of gravitation, but that the dynamical conditions of the problem have not hitherto been explained. I shall endeavour to show the cause of the latter further on.

I now wish to show that gravitation stress and magnetic stress are apparently only different manifestations of the same force.

It is well known that the atoms of matter are of every conceivable size, and of measurable and approximately well-known dimensions. It should further be stated that every form of matter exhibits a specific mode in which it deals with, or otherwise transfers impressed force. This fact is especially proved by the degree of resistance which the various forms of matter oppose to the development of current electricity. This resistance is an inherent property of every substance, varying in degree in each form of matter from silver, the best conductor, up to guttapercha, and the other so-called non-conductors. Resistance forms the basis of Ohm's law.

We have therefore proof, as it appears to me, that whilst gravitation stress, in accordance with the laws of that force, attracts every atom in proportion to its mass, it also gives a definite polarity to each, by causing them to assume a direction which places the optic axis of force in the line of the greatest stress.

I have next to show that the stress of terrestrial gravitation is capable, when affected by the stress of the moon, of the sun, and of the planets, of changing the direction of the atoms, *and thus of imparting motion to the ethereal medium,* in proportion more especially to the number of atoms, and to the rate of the earth's axial motion.

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[*] "Physics of the Ether," S. Tolver Preston, page 14.

The figure represents the earth divided into quarters by the lines N D and E W. The letters A, A, A, A are representative of four atoms, each of which, under terrestrial gravitation, points to the centre of the earth. The arrows and dotted lines show the direction in which the atoms would move under solar or some other external stress. The line C L is supposed to pass through the centre of the earth, and of a body creating stress. The lines S, S, S, S indicate the direction of four lines of solar stress acting upon the atoms.

A careful inspection of the figure will show that the stress of any external body acts upon the opposite poles of the atoms, according to the relation which they hold to the stress. Thus, at A 1 and A 2 the dominant effect is upon the atomic pole most distant from the centre of the earth. This stress tends to drag all the atoms on the sunward surface of the earth into parallelism with the line C L (as indicated by the dotted line arrows), the effect of which will be to compress the ether from the extreme east and west towards the line C L, and to protrude the surface of the mass. It is obvious that the nearer the atoms approach this line the greater must be the expression of the polarising force or stress—*i.e.*, provided the stress of gravitation has the power of arranging the atoms through the influence of what is called the optic axis of symmetry. It will be further perceived that the direction of this axis of symmetry is suddenly changed as the atom passes through the vertical line, C L, and *the effect of this motion must be communicated to the ether.*

If we now consider the action set up on the opposite surface of the earth—viz., that surface most remote from the sun—we find precisely the same influences in operation there, but in a less degree owing to the increase of distance from source of stress. Thus there is the same description of vibratory motion, the same inequality of pressure upon the ethereal medium, and a general tendency to extrude the surface of the earth's mass. We are also justified in the conclusion that vibratory motion and other phenomena are set up in the earth, as the atoms are suddenly brought to rest along the line E W by equality of stress affecting both the atomic poles. It will thus be seen that from the commencement to the termination of an axial rotation of the earth, or indeed of either of the celestial bodies, owing to the influence of stress polarising as well as gravitational, there is no such thing as one continued, even movement of the atoms in the earth's crust; but, on the contrary, that the atoms on the eastern as well as on the western hemispheres are continually being dragged by gravitation stress into lines more or less parallel with the line of the greatest stress; further, that the position of the atoms is rapidly modified by change in the position of the bodies undergoing axial rotation; and further still, that the effects of the influence of the sun upon the earth are continually being modified by changes in the relative positions of the moon, or of the planets to the earth and to each other—the disturbing influence of which with regard to the moon are rendered so evident in their effects upon the tides.

I venture to think that these intermittent intensities and gravitation stresses, through change in the position of the atoms and the constant efforts which are thereby made to bulge the surface of the earth by leverage applied to the atoms individually, affords ample explanation of the dynamics of the tides.

Another glance at the figure will show that the direction of the atomic motions varies considerably. Thus, looking at the figure from D to N, we find that on the right, or east, side of the line C L, the motions take a left-hand direction; whilst on the left, or west, side of the line they are directed to the right; and that the reverse of these two actions occurs on the further, or night, side of the earth. This is another cause for variations in the intensity of the action, because in two quarters (two and four) these accord with the direction of motion; whilst in the quarters one and three the motion is originated in opposition to the earth's axial rotation. We may further assume that as the vibrations caused by these atomic motions are continuously propagated to the inter-atomic ether, the earth's axial rotation causes them to continue their course round the earth, until, under the influence of solar and lunar stress, they are brought to foci at the magnetic poles, from each of which they are projected, and impressed upon the surrounding ether, communicating to it a new and well-defined motion, the direction of which must agree with the angle at which they emanate from the earth.

In this brief summary of facts it is impossible, except in the most general way, to deal with the relative effects of the sun and moon in the production of the site of the magnetic poles. All that can be done is to point to what appears to be the prevalence of a very simple but great principle—viz., that magnetic effects, characteristic of the mass of the matter, are produced in every axially rotating body in the universe, owing to the particular mode in which the inclination of each mass, as a mass, modifies the direction of stress.

There is one other point to which I must refer, and that is the truly helical nature of magnetic force as defined by this theory.

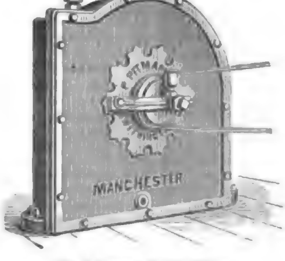
I have shown (1) that the ether takes a direction round the earth which coincides with its axial rotation, only in the opposite direction; (2) that each stress which acts upon the earth imparts to the ether vibratory motion which is characteristic of the inclination of the bodies engaged in the production of the stresses, and is, therefore, of a helical nature. A little further consideration will show that this vibratory motion takes a right-hand helical direction round the south and a left-hand helical direction round the north pole; an arrangement which, as it accords with the known laws of electromagnetism, adds another link to the chain of evidence by which this theory is supported.

Perhaps the best method of realising the direction of these helical currents is to imagine oneself standing on the line of the ecliptic facing the north; the ethereal current and magnetic vibrations will then be passing from right to left—*i.e.*, from east to west. If the position be reversed, and the face directed to the south, the relative motion of the ether will carry the effects of the atomic motions from left to right round the south pole, the result being the north and south magnetic poles in the vicinity of the geographical ones.

TRADE NOTES—ELECTRICAL AND MECHANICAL.

THE DEMON WATER MOTOR.

The enquiry is often posed, where to find a small, cheap, and efficient water motor for driving small dynamos for laboratory or trade purposes. We illustrate herewith a neat little motor, known under the name of the "Demon" water motor, which has been successfully used for such purposes. The motor consists of a simple arrangement of force-buckets propelled under high-pressure house or other



No. 2 Demon Water Motor.

water supply. Inside the case is a thin drum of considerable diameter, on the circumference of which are small double buckets. The water entering by the supply pipe impinges with force on these buckets, and drives the wheel with considerable rapidity and power. The water falls out of the exhaust, and is run away or can be led into cisterns for other use. The shaft and all wearing parts are of hardened steel, gunmetal, and brass, fitted with an efficient system of oil-cups and locknuts. The cover is easily removable for inspection and repair, but the mechanism being very simple, the motor will run for months without attention other than turning on or off the water and occasional supply of oil. It makes no noise, starts easily, occupies exceedingly little floor space, and is of high efficiency. These motors are very cheap, the price being only £1 for the smallest ¼ man, and £3 for two man power, the latter size being capable, with larger supply pipe, of working up to five man or even 1 h.p. The following are details of the motors :

No	Bore of pipe.	Diam. of pulley.	Approx. weight.	Dimensions of motors.		Revs. per minute.	Approx. power.
				Height.	Width.	At 60lb. pressure.	
	Inches.	Inches.	lbs.	Inches.	Inches.		Man.
1	¼	2½	24	9	8	1,800	quarter
2	5/16	3	36	12	10⅜	1,500	half
3	⅜	4	50	15	13½	1,200	one
4	½	5	75	18	16¼	800	two

The motors have been used for telephone dynamos and small electric light installations up to 50 c.p. When worked from the Hydraulic Supply Company's mains they will indicate up to 5 h.p. on the brake, and the cost of running is 25 per cent. less than a gas engine, while the first cost is not to be compared. The running of dynamos is very smooth and regular, equal to that of a high-class steam engine. A "Demon" water motor can be seen in Manchester driving a small Manchester type dynamo. The maker of these water motors is Mr. P. Pitman, Aubrey-road, Withington, Manchester.

DESCRIPTION OF THE STANDARD VOLT AND AMPERE METER USED AT THE FERRY WORKS, THAMES DITTON.*

BY CAPTAIN H. R. SANKEY (LATE R.E.), MEMBER, AND F. V. ANDERSEN, ASSOCIATE.

1. Introductory.

It is well known to many electricians that Messrs. Willans and Robinson have established at their works at Thames Ditton a complete arrangement for measuring accurately the steam consumption of their engines. To obtain the efficiency of combined sets of engines and dynamos, measurements must of course also be made of the electric current and pressure, and it was found that even the best ammeters and voltmeters in the market could not be relied upon to give the same degree of accuracy as was obtained in the steam-consumption measurements. Moreover, all such instruments laboured under the disadvantage that they were calibrated elsewhere, so that the results were dependent upon other people's measurements to a degree which was thought to be undesirable.

After a series of investigations—commenced as early as 1887—into the question of the class of apparatus which would be most likely to give satisfactory results under the special circumstances, a scheme was drawn up in 1889 for a complete apparatus for measuring currents, differences of potential, and resistances, and the various instruments were designed and ordered. It was not, however, until the beginning of the present year that time and opportunity were found to have the apparatus put to practical use, various additions and improvements being introduced as the work proceeded.

As will be seen in the sequel, no new principles have been introduced in electrical measurements with the present apparatus. It was thought, however, that a complete set of workshop instruments, fulfilling the conditions for high accuracy, and yet possessing the simplicity required for everyday use in an engineer's shop, would be found of sufficient interest to electrical engineers to justify a short account of it being brought before the Institution.

The more important conditions imposed in designing the apparatus were that :

1. All measurements made must be capable of verification at any time by a direct comparison of certain resistance coils with a standard ohm, and of a constant potential difference with a standard cell ; and that the arrangements should allow of these comparisons being made quickly for the satisfaction of those interested in the accuracy of the measurements.

2. Volts and amperes must be indicated by direct deflection on a scale, and no balancing operation be required from the observer by torsion arrangements or otherwise ; and the value of the readings must not be influenced by the working of dynamos or the moving of large masses of iron within a few yards' distance.

3. The ammeter as well as the voltmeter must be left in circuit permanently during trials of any desired length.

4. The errors to which the measurements are liable should not exceed 1-5th per cent.

5. The range such as to allow of measurements being made of pressure from 1-1,000th part of a volt to 700 volts, and of current from 1-40th of an ampere to 1,100 amperes.

2. Apparatus Required.

The complete apparatus comprises the following :

I.—*For Measuring Amperes.*

1 D'Arsonval galvanometer.
1 high-resistance box, adjustable by the unit, for use in series with galvanometer.
1 rheostat of platinoid strips for carrying the main current.

II.—*For Measuring Volts.*

1 D'Arsonval galvanometer.
1 high-resistance box, adjustable as above, for use in series with galvanometer. A Wheatstone bridge box is used for this purpose.
3 potentiometer rheostats, 250 ohms each, made of platinoid wire on screwed slate rods, carrying capacity up to one ampere.

III.—*For Calibration.*

1 Clark standard cell containing two elements.
1 standard ohm.
1 standard rheostat of five platinoid strips, arranged for coupling in parallel or series, each strip capable of carrying 10 amperes.
1 mercury rheostat, capacity 50 amperes.
1 secondary battery, three large cells (15L E.P.S.).
1 key with double set of contacts, for use with standard cell.
1 resistance coil, 10,000 ohms, for use with same.
2 1-9 shunts for galvanometers.

IV.—*General.*

Leclanché cells for bridge test, keys, ebonite pillars for connections, etc.

The methods of using the apparatus for actual measurements will first be described, after which the calibration of the galvanometers and the verification of the various resistances will be discussed.

3. Measuring Amperes.

The apparatus used for this purpose is shown on Fig. 4, with the connections in red. On the same figure is drawn the voltmeter arrangement, in order to give the general arrangement of the whole set of instruments. The circuits of the voltmeter arrangement are in black. It will be seen on Fig. 4 that for current measurements the method of measuring the fall of potential across a known resistance has been adopted. The measurement of this resistance—*i.e.*, the resistance of rheostat B, Fig. 3 and Fig. 4, which, of course, must be made with great accuracy—could not be taken satisfactorily by a Wheatstone bridge, owing to its small value (about ·001 ohm). The method adopted for this purpose will be described further on.

The scale of the D'Arsonval galvanometer, G_1, has, in addition to the ordinary millimetre scale, another scale graduated to read from 0 to 1,100 amperes, on which the divisions are proportional to the corresponding currents through the galvanometer, the relation or constant connecting the deflections with this current being known from the calibration of the galvanometer.

By modifying the resistance, R, used in series with the galvanometer, the constant of the ammeter can be modified to suit the number of amperes to be measured. If

k = current through G per unit deflection on ampere scale ;
K = " " B " " " "
B = ohms resistance of B ;
G = " " of galvanometer ;
R = " " in series with galvanometer ;

---

* Paper read at last night's meeting of the Institution of Electrical Engineers.

then for any deflection, D, on the ampere scale (G + R) k D = K D B ; and so

$$R = K\frac{B}{k} - G \quad . \; . \; . \; . \; . \; . \; . \; . \quad (1)$$

In the present case we have,

B = ·0010882 legal ohms at standard temperature ;
G = 429 ,, ,, ,, ,,
k = ·06 × 10^{-6} amperes ;

and therefore the resistance, R, to be used in series with the galvanometer to obtain different ammeter constants = K × 18,137 − 429 legal ohms.

Table I. gives the constants in use, and the corresponding values of R.

The following are the corrections for temperature which must be made in R in order to get the accuracy desired :

1. For the galvanometer, at the rate of 1·66 ohms per deg. C. variation from the standard temperature—in this case 17deg. C.

2. For the rise in B due to the current at the rate of ·023 per cent. per deg. C., the amount of resistance per degree is given in the third column of the table ; and the constant for calculating, from the current, the rise of temperature in B, as determined by experiment, is given in the fourth column.

When the main rheostat, B, is made from the same metal and placed in the same room as the resistance-box R, the periodic temperature variations in the atmosphere do not affect the measurements of the current through the increase of the resistances of these two instruments, as the increase in one balances that in the other.

TABLE I.

Ammeter constant, K.	R in legal ohms.	Correction legal ω per deg. C. of rise in B.	Remarks.
1	17,708	4·17 + γ	Rise in B.
0·5	8,639	2·09 + γ	= $C^2 \times 2 \times 10^{-6}$ deg. C.
0·1	1,385	0·417 + γ	γ = 1·66 (17 − t).
0·025	24	0·0417 + γ	t = temp. of G in deg. C.

For ordinary work the readings on the scale are amply accurate, as they can be depended upon to be within ·3 per cent. of error.

For very accurate trials, however, the scale is used only to ensure the practical steadiness of the load, and for taking readings at short intervals in order to obtain the mean reading. The current corresponding to this mean reading is then determined by direct comparison with the standard ohm and cell.

This determination of the current is made by substituting in the galvanometer circuit an E.M.F. equal to that of the standard cell for the P.D. on the terminals of B, and then, by shunting the galvanometer and adjusting R, reproducing the deflection in question. If, then,

C = the current to be determined ;
G = ,, resistance of the galvanometer ;
R_1 = ,, ,, in series with G when standard cell is in circuit ;
R = ,, resistance in series with G when B is in circuit ;
e = ,, E.M.F. of standard cell ;

and if the shunt was of a multiplying power = m : then

$$C = \frac{R + G}{m R_1 + G}\,\frac{e}{B} \quad . \; . \; . \; . \; . \; . \; . \; . \quad (2)$$

4. MEASURING VOLTS.

The apparatus for this purpose is shown on Fig. 4 (with connections in black) in a diagrammatic form. It consists of a D'Arsonval galvanometer, G_2, with a resistance, R, in series, and a rheostat, P, connected with the difference of potential leads—for instance, with the terminals of a dynamo.

The scale of the galvanometer has a second graduation constructed in accordance with a calibration, so as to have its divisions proportional to the corresponding currents through the galvanometer. This proportional scale is divided from 0 to 175 volts, and unit deflection on the volt scale is produced by a current through the galvanometer of one micro-ampere.

In measuring P.D.'s smaller than one volt, the rheostat P is not used, but the P.D. to be measured is directly connected into the circuit of G_2.

When measuring P.D's higher than one volt, the P.D. to be measured is connected across the rheostat P, of which a small section—"a" on Fig. 4—is connected with the circuit of G_2. This section "a" is so adjusted as to be exactly 1-100th part of the total resistance of P + the dynamo leads, which sum is = 250 ohms.

The ratio $\frac{a}{P + \text{leads}}$ is called the potentiometer factor.

When it is required to measure high voltages, a second and even a third rheostat, P_1 and P_2, each of 250 ohms, can be joined in series with P, and so the potentiometer factor altered from 1-100th to 1-200th or 1-300th. Further alterations can, of course, be made in the voltmeter constant by varying the resistance, R, as in the case of the ammeter.

The potentiometer factor is evidently independent of the temperature of the rheostats P. The temperature correction required in R is simply ·023 per cent. of R* + ·388 per cent. of G per deg. C. of variation. It will be seen that for the ordinary ranges the resistance of the galvanometer—about 435 ohms—is very small compared with R, and that therefore the errors in the measurements due to unavoidable small errors in the estimation of the temperature of R are quite insignificant. If

k = current through G per unit deflection of volt scale ;
K = volts to be measured ,, ,, ,, ,,
f = potentiometer factor ;
G = ohms resistance of galvanometer ;
R = ,, ,, in series of galvanometer ;

then, for any deflection, D, on the volt scale,

$$(G + R)\,k\,D = f\,K\,D\,; \;\therefore\; R = \frac{f}{k}\,K - G \quad . \; . \quad (3)$$

In the present case,

k = 1 micro-ampere = 1 × 10^{-6} amperes ;
G = 435 ohms (legal) at standard temperature ;

therefore, the resistance, R, to be used in series with the galvanometer to obtain different voltmeter constants = f K − 435.

Table II. contains, in column 1, the constants used with the instrument ; in column 2 the corresponding values of R ; and in 3 the value of the temperature correction in ohms per deg. C. deviation from the standard temperature—17 deg. C.

TABLE II.

Voltmeter constant, K.	R in legal ohms.	Correction per deg. C. from 15 deg. C.	Remarks.
0·0005	60	1·68	Direct connection.
0·001	555	1·80	
0·005	4,517	2·71	
0·01	9,469	3·85	
0·05	60	1·68	1 potentiometer rheostat.
0·1	555	1·80	
0·5	4,317	2·71	
1	9,469	3·85	
2	,,	,,	2 ditto in series.
3	,,	,,	3 ,, ,,
4	12,773	4·61	3 ,, ,,

NOTE.—The resistance, R, by formula (3) is, of course, in true ohms ; the amounts of R in Table II. are given in legal ohms, as the resistance-boxes available were adjusted in legal ohms. For the purpose of reduction, one legal ohm has been taken = ·9977 ohm. The figures have further been reduced about 1·2 per cent. to balance a change of constant.

The strongest current which at any time will pass through the galvanometer circuit is the current which deflects to the end of the scale, or ·000175 ampere. The heating caused by this current in the galvanometer, as well as in the resistance-box, coils is quite inappreciable, and the galvanometer may therefore be left "on" for any length of time.

For everyday work the scale is used, the readings being well within ·3 per cent. of error. For more accurate work, however, readings are taken at intervals, and the mean reading is afterwards calibrated against the standard cell as follows: The determination of the P.D. corresponding to the given mean deflection being made by substituting for it an E.M.F. equal to that of the standard cell, shunting the galvanometer, and adjusting the resistance in series with it till the deflection is produced. Then, if

E = the P.D. required ;
r = total resistance of potentiometer rheostat plus dynamo leads ;
$r\,a$ = section of this resistance tapped to galvanometer ;
R + G = resistance of galvanometer circuit when G is used as voltmeter ;
R_1 + G = resistance of galvanometer circuit when standard cell is used ;
m = multiplying power of shunt when standard cell is used ;
e = E.M.F. of standard cell at the given temperature :

we have,

$$E = \frac{r}{r\,a}\,\frac{R + G}{m R_1 + G}\,e \quad . \; . \; . \; . \; . \; . \quad (4)$$

[The figures referred to will be given in the conclusion of the paper next week.]

(To be continued.)

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* The coils being made of platinoid wire.

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FOLLOW AFAR.

When Frenchmen initiate an electrical exhibition at Paris, a congress or conference follows as a matter of course. When Germans initiate an exhibition at Frankfort, the inevitable congress is also held. When Americans condescend to go in for a universal exhibition a congress will be a necessity, and we may be sure that it will be thoroughly organised and be successful. By the bye, has any student of language noticed how rapidly Americanisms are becoming common? This is largely due to the fact, no matter how we may kick against it, that America is becoming the centre of the world's action. Its newspapers initiate new departures, and the Old World copies, sometimes with acknowledgement, more often without. Hence we, too, often "locate" an engine instead of "place" the engine. Its "location," not its position or "situation," is good, bad, or indifferent. It is the Chicago "Exposition," not the old English "exhibition," and so on through the whole gamut of newspaper literature. Then again, many people in this country have suggested the necessity of meetings somehow and somewhere of the "conventions" kind so common in America, where papers on practical questions are read and discussed. The English characteristic is to pretend all one's manufacturing and constructional details are of immense value, and keep them absolutely secret. The Englishman, in fact, pretends to a supernatural knowledge of details over and above his fellow. This secrecy about matters electrical is ridiculous, for there is *no single* practical detail that is not easily made clear to anyone who likes to investigate. As for the nine hundred and ninety-nine paper details, many of which find their way to the Patent Office, they are not worth the paper they are written upon. We contend, then, that the Englishman might well be as free with information of his manufacturing and constructional details as is his American brother. The Institution of Electrical Engineers has in a small measure broken down a few of the old traditions, and many, if not most, of its papers are now more practical in character than they were a few years ago. But there is still too much of the scientific society about them. The attempt at trimming is not always happy, and many would be better with the science cut out and the practice left in. We are convinced that the young electrical engineer will learn more from the practice of the older members than he will from their science. It is time it was instilled into him from headquarters that science teaching varies with every new practical departure, and that business consists of practice, not dreaming after the departure has taken place. There is to be an exhibition at the Crystal Palace in the New Year. We would suggest to the organisers of this exhibition that some attempt be made to get up an "English congress" in which the papers read should be intensely practical, and that theorising should be entirely tabooed. Let us have simple practical directions as to how to do this and how to do that, how this is done and how that is done, what result is obtained by this combination and what by those combinations. We do not care for the moment what ought to be done, or what ought to be the result—we want to know the actualities of the case. For example, we do not believe one single central station authority is prepared to publish the exact truth as to the losses between the generation and the selling. They will all tell you the efficiency of this machine and that machine, of the theoretic loss through leads, wires, and connections—but that is all. We do not know the actualities of any single case. The same holds as regards motive power, traction, its cost and its returns. Almost all our figures on these points are from American sources. The Institution is about to commence its autumn session. Will it be as it has been, that at least half the hearers are guests, and not members, students from schools, who are told it is the thing to attend the meetings? No doubt the room is thus filled; but does absence prove that members are interested in the papers read and discussed? The Crystal Palace authorities would be wise to spend £100 or so upon the preparation of half a score of papers upon practical points by practical men, if they cannot manage a new departure without. Can they get the truth about the use of secondary batteries in traction work? Many of us have a pretty good idea of how the facts stand, but no official or authoritative statement. The result of their use is either good or bad. If the former, why this secrecy; if the latter, what is the use of pretending they are what they are not? Time, and a very short time, will show the want of success. Meanwhile men are waiting authoritative figures, and business is delayed and lost by silence.

CHARGING ACCUMULATORS BY ALTERNATING CURRENTS.

The facility of transmission of electrical energy by high-pressure alternating currents, together with the ease of transformation of pressure up or down, seems to indicate the alternating-current system as that best to be used for transmission of power over distances, and thus for the utilisation of natural forces. The continuous-current system, by reason of the possibility of storing the energy by charging accumulators, equally seems to indicate the continuous-current low-pressure system as that best to be used for regular and constant system of electric light in towns. Electrical engineers have too long been divided into rival camps upon this question—one apparently absolutely avowing belief in no system that uses alternate currents, and the other as positive that the use of storage batteries is a mistake. Those who have committed themselves on the side of continuous currents, too often seem to forget that all dynamo armatures in reality produce nothing but alternate currents, and their devotion to continuous currents is but to the enemy under another name. While those who have allied themselves exclusively on the side of the alternate currents have always to deal with the fact that they cannot possibly sell more than a certain not too high percentage of the current generated, and that engines constructed to run economically at full load are both wasting capital and coal when running at anything beneath this full load. What reason is there that the rival camps may not join forces, in cases, at least, where electrical energy has to be transmitted over some distance, or where natural forces are open to be utilised? Why not, it may be asked, generate your energy in alternating currents, and transmit it at high pressure, commute the currents not at the generating but at the receiving end, and use this continuous current to charge accumulators? Engineering difficulties—too complicated, is the answer. Well, in one way, this answer is sufficient.

A scheme was announced some time ago by a sanguine young electrical engineer—Mr. Pritchett, if we rightly remember—somewhat on these lines. The large engines, he maintained, which were always necessary for alternate-current distribution, never worked *on an average* over 30 or 40 per cent. of their full power. He proposed to use either an engine or water power continuously to drive an alternate-current dynamo, receive the current at an alternating-current motor, which would drive a continuous-current dynamo which should continuously charge accumulators; these during the night would drive a continuous-current motor, and this again drive an alternate-current dynamo, and so distribute to transformers at the private houses. By working the turbine or engine at full power the whole time, it was expected that a gain on both first cost and in efficiency would yet be obtained. We are not aware whether this scheme was ever tested, but it is pretty evident that such a complicated system would not gain the support of central station engineers.

The question has, however, recently been modified by the introduction of a new factor, which may render a reconsideration of the problem necessary, due to the initiative of Messrs. Schuckert at the Frankfort Exhibition. Messrs. Schuckert exhibit dynamos, each of which will act either as generator or motor, and will produce either alternate or continuous currents at will. It will act as an alternate-current motor, and yield either power or, if desired, continuous currents direct without further apparatus. The principle of the machine is ridiculously simple, and it is a wonder why no one ever thought of doing the thing before. Every Gramme ring produces alternate currents when rotated; these are commuted into continuous currents at the segments of the commutator. If, however, the currents were also led to a set of ring collectors, evidently the dynamo would produce alternate currents. By arranging four connections at points at right angles to each other from the ring, these alternate currents will differ by 90deg. in phase, and produce a rotating field if led to a similar armature of a second machine. If the field magnets of this second machine were excited by a continuous current, this second machine would, and does in practice, act as an alternating-current motor. But being rotated in a magnetic field it will give off alternate currents from its coils exactly as when rotated by an engine, and if these currents are commuted by the ordinary armature these currents will be continuous currents, part of which can be used to excite its own magnets in shunt, and the remainder can be used for charging accumulators. All that is necessary to effect this change is to add four ring collectors to an ordinary shunt machine. Such motors were at work at Frankfort, and from these at will could be taken alternate currents, direct currents, or power from the pulley. Here we have a machine which evidently brings the problem stated at the beginning of the article within easier reach of solution. High-pressure currents can be generated, using the engine at full power continuously. These can be received by a double-commutator dynamo, taken off as direct currents and used for charging accumulators, from which the supply would be drawn off as required, upon the three-wire system. For stations in the centre of their district this system offers no advantages, but for those at which water or other power at a distance is to be used (and it would be well, theoretically, to have all generating stations away from the houses) the method seems to offer very considerable advantages, and as a means for reconciling the two rival camps, if it prove practical and efficient, must be hailed with pleasure by all who wish the extended success of both.

TELEGRAPHS AND GALES.

The following from the *Times* of November 12, A.D. 2,000, cannot but prove of interest at the present juncture: "A furious gale, amounting in some places to a hurricane, raged along the south and eastern coasts during the last two nights, causing a large amount of suffering and damage to shipping, besides many land casualties both in this country and on the Continent. Fortunately, we are able to give full reports of the damage done, as well as to continue the full publication of telegrams from the Continent and America owing to the underground land telegraph lines which were recently completed. Indeed, it is difficult to conceive of the state of mind that so long allowed the uncertain communication of overhead wires alone to continue, by which any gale or snowstorm of more than usual force would throw down the lines and destroy all telegraphic communication with the Continent and the West of England and America within a few hours. It could not be maintained that the additional cost of a few trunk underground wires was too great for the Government to undertake, for the question was one of national importance. The Commission, which at last was obliged to be forced upon the Department, found, as will be remembered, overwhelming evidence of the immense losses to commercial and national interests which occurred at every total interruption of the great telegraph lines through the accumulation of messages, often of the utmost and vital importance. In Germany the wires were already placed underground for war purposes, and the conclusion at last arrived at, that an undertaking Germany could accomplish for war purposes Great Britain could certainly carry out for commercial purposes, has been abundantly justified by the admirable way in which the service has been continued without interruption during the late stupendous gales. It is also a matter of the utmost significance that the greatly reduced list of total wrecks and casualties which have occurred this season is almost entirely owing to the admirable system of coast guard, lighthouse, and lifeboat intercommunication by telegraph and telephone, which has at last been established."

MAGNETIC RELUCTANCE.*

BY A. E. KENNELLY.

The science of magnetism was a collection of facts concerning magnets until Coulomb first brought to light a quantitative relation between a few of its phenomena, and thus entitled it to appear among the exact sciences. He determined by measurement that the forces of attraction or repulsion between the poles of long, thin bar magnets were proportional to the strengths of those poles, and inversely to the square of their intervening distance.

In one respect it has since been shown that the discovery was unfortunate, for it served to depress rather than to stimulate further enquiry into the laws of quantitative magnetic relationships. The application of Coulomb's law soon brought into use a conception of magnetism, suggested, perhaps, by the analogy the law bears to that of gravitation force. This was the hypothesis of a layer of fluid or imponderable matter resident on the surfaces of magnetic bodies, and endowed with attractive and repellent forces on all portions of such fluid in exact similarity to the two-fluid theory of electricity. Each element of surface magnetism would exert, according to Coulomb's law, a definite force upon every other element of its own, or of other magnet surfaces, and when the distribution of the magnetic matter or fictive layer was known, the total forces active between the magnets forming the system could be determined by the summation of all the elementary actions. This was the polar conception and mathematical theory of magnetism. It was not only artificial; it was also misleading. It assumed that definite action could be exerted at a distance, ignoring the action of the intervening medium. Nevertheless, a slight modification of the polar theory rendered it capable of expressing a mathematical theory of magnetism with apparent success, and exhibits in this respect, like the theories of gravitation, the remarkable construction of purely artificial frameworks of thought, void of all attempt at reality, yet capable of affording useful applications and exact quantitative results, while beneath their foundations the real and natural active forces still lie in undiscovered concealment.

It was soon apparent that magnetism considered as a fluid could not be confined to the surface of bodies, since it was only necessary to break a bar magnet asunder in order that new poles and new magnetic fluid should be exhibited. The amendment to the original theory was then framed that a condition of molecular magnetisation extended, vein-like, throughout the substance of the magnet. The termination of each vein at the surface exposed a definite quantity of polarised magnetic matter, while within the veins the polarity was neutralised by the successive layers of opposite molecular poles. This was a great stride beyond the original theory, for it ascribed magnetism not alone to a fictive superficial layer, but to the combined effects of all the molecules in the magnetised body, whose substance, no ger a mere frame for supporting the layer, became sted throughout with a definite condition.

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* Paper read before the American Institute of Electrical Engineers, October 27, 1891.

he amendment in time became classical, and subverted original conception, for the polar theory only recognised erficial magnetism, while the vein theory did not make such reservation. It was only necessary to assume t the veins varied in richness at different parts of the gnet, or that they might be subjected to faults and tial discontinuities, to introduce unneutralised polarity hin the mass which might be capable of exerting external uence, a condition neither the simplest nor most usual, which the experiment of superposed magnetisations in el has rendered familar. This irregularity of vein struc- e would add a volume distribution of magnetic fluid ough the interior of the magnet to the surface distribution the outside.

n the vein theory, the intensity of magnetisation at point of the magnet would be defined as the amount magnetic matter cut through in the veins per unit area a plane section perpendicular to their direction, at the nt in question.

A unit magnetic pole, situated in free space, at the end a very long thin bar magnet would by definition repel h unit force a similar pole one centimetre distant—that resident on the surface of the sphere one centimetre lius, of which it occupied the centre. The surface area this sphere would be 12·57 (4π) square centimetres, and er all this surface the pole would thus establish a gnetic field of unit strength and exert a magnetic stress ual to unity. Each square centimetre of the surface unds an area of stress which emanates from the pole, and nsequently the latter must emit 4π units of stress flux. the language used by Faraday, it would throw off 4π es of force. This stress flux has somewhat unfortunately ceived from Maxwell the name of induction, and the duction through the surface surrounding the pole would 4π units.

The interest connected with the nature of this stress mands a moment's pause at this point. While its real aracter is still as great an enigma as the real character magnetism itself, some of its laws are well understood. here exists along the direction of the stress a tension companied by a general pressure at right angles, just as the case of stimulated muscular fibre, which tends to orten and expand laterally, or, as it is generally expressed, e lines of force tend to contract while repelling one nother. Since the time of discovery that the plane of dulation in polarised light waves twists in passing through rtain magnetised substances it has been supposed that e stress might be of a rotatory character. Like an incom- essible fluid, it can neither accumulate nor vanish locally, d as much stress flux must leave any region as enters it, no magnetic pole exist within the confines. Its intensity very remarkable, for it is far in excess of any stress that e can exert without the aid of cohesion in matter. This ay be judged by comparing the quantities of energy that n be stored in a given volume of space, say, air space. It , of course, easy even without the assistance of iron to agnetise a cubic centimetre of air to a flux density of ,019 C.G.S. lines, when it will possess an energy stored p in magnetic stress of one megalerg (1,000,000 ergs r 0·0737 foot-pound) while if this magnetisation be lternated 227 times per second the average rate of absorp- on and discharge would be 45·5 watts, and one cubic inch f this air would stow and release energy with the average ctivity of one standard British horse. Under electrostatic tress, air, not in the immediate neighbourhood of a con- uctor, appears to break down when the E.M.F. per linear entimeter exceeds 32,000 volts or 100 A.E.S.U., so that he maximum electrostatic energy that one cubic centimetre ill hold without rupture is about 500 ergs, or 2,000 times ss than that resident in air stressed magnetically to 5,000 nes, while a cubic centimetre of air near the earth's surface lumined by bright sunlight does not hold more radient nergy than about 50 microergs.

An alternating-current transformer is a device in which he secondary coil absorbs the energy out of air and iron, ervaded by the stress flux from the excited primary oil. Unfortunately, while magnetically stressed air yields, o far as we know, all its stress energy back into either the primary or secondary circuit, stressed iron fails to do so entirely, and absorbs energy at every cycle, a process known as absorption by hysteresis. The iron directly converts the magnetic stress energy into heat energy, just as a spring absorbs some of the energy imparted to it during every cycle of compression and recoil.

These 4π units of stress flux are not confined to a spherical surface of one centimetre radius, but would be found by summation over any enveloping surface containing a single unit pole, just as the delivery of material liquid must be the same in a steady stream at any section of its course independent of the channel area there existing; for at 10 times the distance the spherical area would be 100 times greater and the stress by Coulomb's law 100 times less, leaving the total area of total stress unchanged, and it follows, in fact, that the stress flux over any boundary is always 4π times the strength of pole enclosed, no matter whether that pole be alone in space, or be the sum of any number of magnetic systems, in molecules or in masses.

On the vein theory, however, the strength of a pole is the quantity of magnetic matter on its surface, assuming that the veins meet it perpendicularly, or it is the aggregate surface intensity of magnetisation, so that the stress flux through each unit of polar surface is 4π times the intensity of magnetisation. This is true not only for the polar surface, but also for the interior of the magnet, and every unit vein of magnetic polarised matter carries associated with it a stress flux of 4π.

The magnet may itself be situated in a field of force, so that its substance may be pervaded by a stress flux independent of that in its veins. It may, and generally does, happen that part of this separate stress flux issued from its own poles, in which case it will enter in the opposite direction to the vein or internal flux, and will tend to reverse the molecular polarity of the vein structure; but whenever such additional flux is present, the resultant total flux at each point will be the geometrical resultant of that in the veins, compounded with the external flux by the parallelogram of forces. In the important case of a long bar of homogeneous soft iron submitted to the influence of a uniform magnetic field acting in the direction of its length, there will be a uniform induced molecular polarisation or magnetisation set up along the bar. Suppose, for instance, a bar of iron five square centimetres in uniform cross-section pointed in the direction of the dipping needle near Paris. The earth's field there being 0·46 unit, or its stress flux 0·46 units over each normal square centimetre, that stress would be active in setting up polarity in the molecules of the iron along the bar. The degree of magnetisation would be also influenced by its own resulting polar stress unless this effect could be rendered insensible by sufficiently extending the length and thus carrying the poles out of the field. With a very long bar magnet the magnetisation would be everywhere about 40 times this strength of field, or numerically 18·4 units, and on the vein theory there would therefore be 18·4 units of magnetic matter exposed on the surface of each square centimetre in a slice made across the bar at any point, or 92 units over the whole section. The polar surfaces would also be covered by 92 units of positive and negative matter respectively. Associated with each unit vein of polarity, however, would be 4π units of stress flux giving a total flux of 1,156 units in the bar, which would emerge from the polar surfaces and unite in surrounding space. The whole induced system would, however, be immersed in the earth's field that evoked it, and which would be superposed upon it throughout. There would thus be 1,156 + 2·3 or 1,158·3 units of flux, in ordinary phraseology 1,158·3 lines of induction through the bar, a density of 231·6 C.G.S. units per square centimetre. The law that the whole flux is the field flux compounded with the induced flux of 4π times the magnetisation, which holds uniformly at all points throughout the bar in this simple case, is true at any individual point in the most complex case, however variable the field or magnetisation may be.

The fact that the stress flux has the same total value over any envelope surrounding a magnetic pole, however widely the stress may be diffused and rarefied, that it follows curves in space whose resistance can be rendered evident by iron filings and curves that form closed loops through the substance of the magnet itself, gradually suggested the notion of a magnetic circuit in which the circulation was neither a fluid nor an energy-exchanging condition like a current but a stress.

This conception once firmly established proved of great advantage. Not only has the dynamo been greatly aided in development by the applications of this theory, but the inter-relationship between magnetism and electricity has been brought into clearer recognition in consequence.

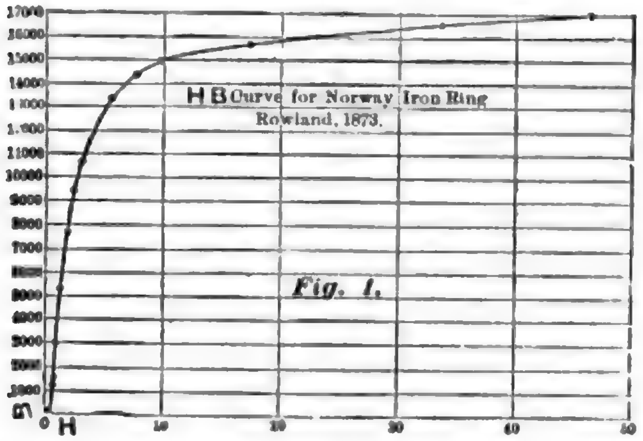

Fig. 1.

From this point of view the ideas and analogies of the galvanic circuit became paramount, and eclipsed the original notions of magnetic matter and magnetisation. All that was essential on this hypothesis was a magneto-motive force in a circuit having conductivity, and a flux or magnetic current resulted. The magneto-motive force in permanent magnets was the result of a definite molecular condition in the iron, while in the neighbourhood of an electric current it was always active. According to Ampère's theory that magnets had molecules in which electric currents ever circulated, the two sources of magneto motive force were united.

Some contention took place between the claims of the vein theory and the circuit theory for the interpretation of magnetic phenomena, and the question as to their relative merits is yet often raised. It seems, however, early to decide upon the acceptance of any theory while the ultimate origin and nature of magnetism remains unexplained, and it is better to regard both theories as working hypotheses to account for the effects of magnetic laws, equally capable of yielding correct results and therefore closely associated, while the preference between them will depend upon the nature of the problem to be attacked. The circuit theory is the simpler for general purposes of theory, and particularly for dealing with the phenomena of electromagnetism.

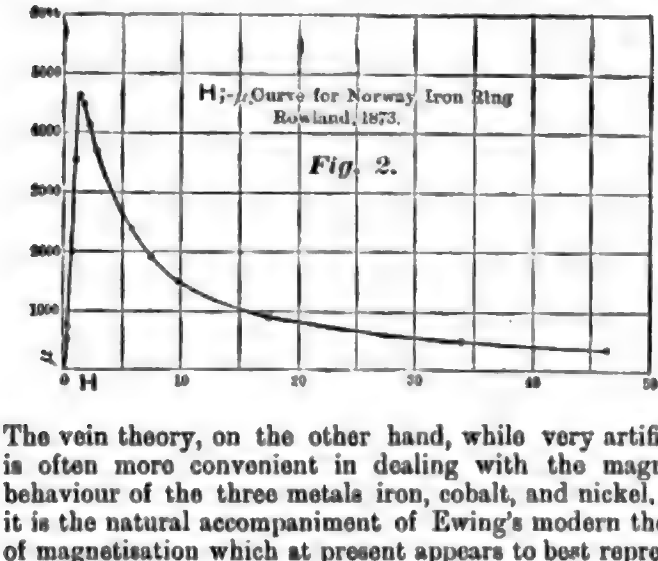

Fig. 2.

The vein theory, on the other hand, while very artificial, is often more convenient in dealing with the magnetic behaviour of the three metals iron, cobalt, and nickel, and it is the natural accompaniment of Ewing's modern theory of magnetisation which at present appears to best represent the facts.

On the circuit theory the magnetic conductivity of all substances is very nearly the same as that of an air-pump vacuum, and constant, notably excepting the three magnetic metals whose conductivity is enormously greater, but variable with the conditions of the circuit.

The existence of magnetic conductivity known as "permeability" necessarily involved the inverse quality of magnetic resistance.* Some debate has taken place as to the validity of this term or its application, for the reason that the resistance which usually enters into practical magnetic circuits is generally far more variable than that found in the metallic circuit of electricity. It is now generally admitted, however, that the term magnetic resistance is fairly applicable in virtue of analogy if not of exactitude. The term magnetic reluctance then suggested by Heaviside, has, however, the advantage that "reluctance" as one word is less cumbrous than "magnetic resistance," and for that reason only it is advantageous to retain it. Similarly the reluctance per unit volume or the magnetic resistance of one cubic centimetre has been called "reluctivity," and is perfectly definite if not quite euphonious under that title. It is this quantity which will occupy our further attention.

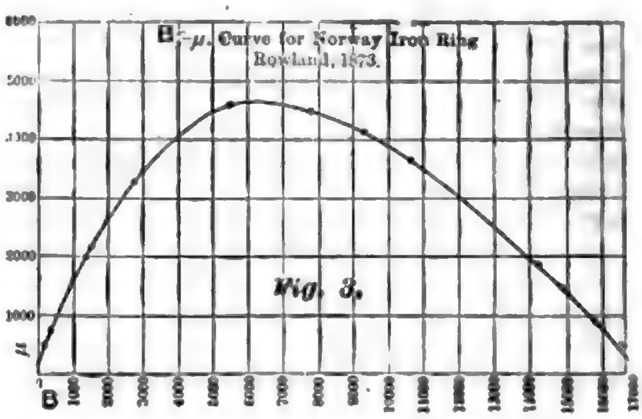

Fig. 3.

This magnetic circuit differs from the galvanic in one important particular. In the latter we most frequently meet with a conductor carrying the flux or current through an insulating medium, such as air in which no current—certainly no measurable current—passes. In the magnetic circuit this condition of things while approximated to and often for practical purposes assumed in dynamos or electromagnets is only realised in one actual instance—that of a closed Faraday ring uniformly wrapped with wire carrying a current. In every other real case the flux is diffused more or less through the surrounding substances and does not follow a simple passage. Magnetic flux, in fact, is not to be enchannelled because there is no known magnetic insulator, and this fetters by complication the quantitative grasp of the subject.

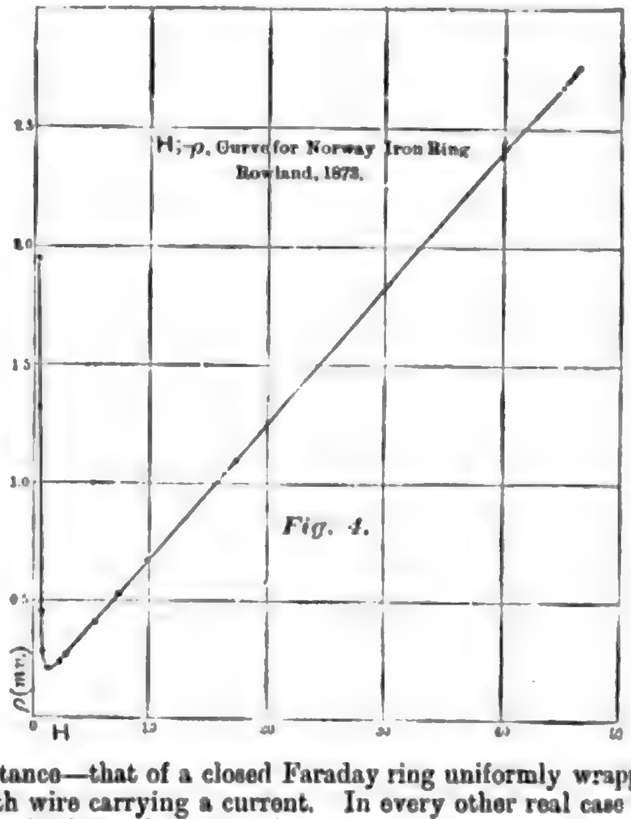

Fig. 4.

The law of the magnetic circuit is like Ohm's law that the flux is equal to the magneto-motive force divided by the reluctance. That is regarding the circuit as a whole. For any one point of the circuit the law is that the flux density is equal to the drop in magneto-motive force per centimetre.

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* Bosanquet, *Phil. Mag.*, vol. xxv., 1888, p. 419.

there existing, divided by the reluctivity—corresponding exactly to the case of Ohm's law at any point in an electric circuit. This "drop" is called the magnetising force, denoted by H, and is the strength of the magnetising field at that point. Owing, however, to the great variation that exists in the reluctivity of iron which enters into nearly every practical magnetic circuit, the law is of much less service than Ohm's electric law. The reluctivity depends not only on the magnetising force, but also on the degree of purity of the iron, and iron possessing 12 per cent. of manganese is almost non-magnetic.[*]

A number of attempts have been made by different observers to establish a definite relationship between the flux density and the magnetising force or the permeability in order to so amend the magnetic Ohm's law as to give serviceable results for even pure iron. The results obtained, excepting the formulæ of Frölich and Lamont, have generally been regarded as unsatisfactory. They have usually been expressed graphically as curves in one of three types:

1. $H - B$, or curves of magnetising force and flux density.
2. $H - \mu$, or curves connecting permeability and magnetising force.
3. $B - \mu$, or curves connecting flux density and permeability.

It is the object of this paper to show that there is a fourth relation that has not received the attention it seems to deserve—namely, the curves connecting the reluctance with the magnetising force.

As an example of the comparative forms of these well-known curves, types 1, 2, and 3 are represented in Figs. 1, 2, and 3 for a sample of Norway iron whose results are among the first on record, being published in 1873.[†] The curve connecting the reluctivity with magnetising force is shown in Fig. 4, and exhibits a greater degree of simplicity than any of the others. Curve 4 consists, in fact, of two lines that are very nearly straight, united by a rounded elbow; and these outlines express the fact that the reluctance of this sample of iron was very nearly a linear function of the magnetising stress brought to bear upon it. The ordinates for this curve are given in thousandths of an absolute reluctance unit, a quantity we may call provisionally a milli-unit, abbreviated M.U. The reluctance of 1,000 M.U. in series would be that of one cubic centimetre of air. Reluctivity curves plotted from various sources, all of which are duly given in the appendix, appear in Fig. 6, for various samples of iron and steel. The general type consists of two lines nearly straight, connected by an elbow which is sharper and more defined as the iron is softer and more nearly pure. With hard steel the change from the descending to the ascending line is very gradual. The reluctivity of iron appears from these curves to commence at a certain definite and moderately large value, which we may denominate its initial reluctivity, descends very rapidly and nearly on a straight line to what may be called the critical reluctivity at the critical magnetising force, turns abruptly, and then advances along a nearly straight line. Before the turning point in Fig. 4 the reluctivity may be expressed approximately by the equation $\rho = 2{\cdot}9 - 3{\cdot}5\ H$, while beyond the bend the equation becomes $\rho = 0{\cdot}1 + 0{\cdot}058\ H$. The flux density existing in this sample of Norway iron can be calculated by the Ohm's law formula for any value of H when the corresponding value of the reluctivity is taken from one or other of these two equations and the resulting curve of $B - H$ will practically coincide with that in Fig. 1, except in the immediate neighbourhood of the critical value of H. This relation also exhibits the foundation that exists for the Frölich formula which has long been known to be practically valuable and even very accurate in application to dynamo-magnetic circuits, although both the method by which it was arrived at and the light in which it has since been regarded appear to have been empirical rather than fundamental.[‡]

(To be continued.)

THE RELATIVE ECONOMY OF ELECTRIC, CABLE, AND HORSE RAILWAYS.

At the street railway convention held in Pittsburg, Mr. J. S. Badger, of the staff of the Edison General Electric Company, presented a paper on "Electricity the Most Economical Power for Street Railways," which gave some interesting and late statistics, and seems to have been carefully and fairly prepared. After pointing out that the two items of first cost and operating cost per car mile furnished the fairest and most useful basis of comparison, and calling attention to the important effect of differences in price of coal and labour, and in intelligent care of the plant, the paper continues:

FIRST COST.

Direct information concerning cable roads has not been obtainable. The figures we cite are those given by the Census Department, and do not seem to have been questioned by any authority. The data concerning horse roads, being taken from sworn reports to the Massachusetts Board of Railroad Commissioners, can also be relied upon. The figures given concerning investment in electric roads have come from official sources, and are confirmed by private information. These are, however, excessive. Most of the roads mentioned were formerly horse roads, and to the original investment has been added the cost of change of motive power, and in almost every case the amount now charged to permanent investment is far in excess of what it would cost to renew the entire power plant, track, and equipment.

An attempt has been made to show that electric roads cost nearly as much as cable roads for equal class of construction. How much a company might, for purposes of its own, or through mistaken ideas, see fit to invest, it is not necessary here to discuss; but as to how much is necessary for first-class construction, there is little question. One of the foremost roads, with an equipment first-class in every respect, has a permanent investment, including paving, almost exactly that given as the average in Table I. Estimates upon track construction differ greatly, but the limit of profitable investment is not likely to exceed 10,000dols. per mile; while as fine and substantial a road-bed as electric car ever ran over was built at a cost, exclusive of paving, of about 5,000dols. per mile.

The overhead structure need not cost to exceed 2,500dols. to 3,000dols. per mile of single track for best wood poles, or 3,500dols. to 5,000dols. for iron poles. For double track, iron poles, it would vary from 4,500dols. to 6,500dols. per mile, centre-pole construction being cheaper and in many other respects preferable where it can be adopted; 3,000dols. to 3,500dols. per car is a liberal estimate for 16ft. to 20ft. cars, fully equipped, and the average is about two cars per mile of road.

An allowance of 15 h.p. to 20 h.p. per car, at 80dols. to 100dols. per horse-power for station equipment, including steam plant but not real estate or buildings, is very liberal.

Thus we have, as an extremely liberal estimate, 26,000dols. per mile, exclusive of real estate, buildings, and paving for a road suitable for the heaviest metropolitan traffic, and it is a fact that a good and satisfactory road can be built and equipped for 20,000dols. per mile.

As records of actual experience, a careful examination of the statistics presented is invited, and especially of those relating to electric railways. The greater part of these has been obtained by personal visits to the roads reported.

COMPARISON OF INVESTMENT AND OPERATING EXPENSES.

TABLE I.	Total investment real estate road and equipment.		Car miles run per annum per mile of street length.	Passengers carried annually per mile of street length.	Passengers carried per car mile run.
	Per mile of street length.	Per mile of track length.			
	dols.	dols.			
22 electric roads*	38,500	27,780	76,158	237,038	3·10
45 horse roads† ...	33,406	31,093	43,345	251,815	5·81
10 cable roads‡ ...	350,325	184,275	309,396	1,355,965	4·38

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[*] Hopkinson, *Phil. Trans.*, 1885, part ii., p. 462.

[†] Rowland, *Phil. Mag.*, 1873, p. 153, Table V.

[‡] Frolich, *Electrotechnische Zeitschrift*, pp. 90, 139, 1881, p. 73, 1882. Silvanus Thompson, "Dynamo Electric Machinery," p. 305; "Lecture on the Electromagnet" I., p. 74. Ayrton and Perry, *Phil. Mag.*, 1888, vol. xxv., p. 506.

TABLE II.	Operating expenses per car mile run.	Interest charge per car mile at 6% on total investment.	Total of operating expenses and interest, per car mile.	Cost per passenger carried, interest excluded.	Cost per passenger carried, interest included.
	Cts.	Cts.	Cts.	Cts.	Cts.
Electric roads*	11·02	3·03	14·05	3·55	4·53
Horse roads†	24 32	4·62	28·94	4·18	4·98
Cable roads‡	14·12	6·97	20·91	3·22	4·77

TABLE III.	Ratio of investment per mile of street length.	Ratio of car miles run annually per mile of street length.	Ratio of cost of operation per car mile, interest included.	Proportional traffic that must be done, per mile of street occupied, to pay operating expenses and 6 per cent. on the investment.
Electric roads*...	1·152	1·757	·485	·852
Horse roads† ...	1·000	1·000	1·000	1·000
Cable roads ‡ ...	10·486	7·138	·726	5·182

* Car miles run per annum, 14,013,187; passengers carried per annum, 43,614,972; street length, 184 miles; track length, 355 miles.

† All the roads in Massachusetts operated exclusively by horses for 1885-90. Average for six years.

‡ From Census Bulletin No. 55.

TABLE IV.—SEVEN REPRESENTATIVE ROADS, OPERATED ENTIRELY BY ELECTRICITY.

Road.	Length.		Passengers carried annually per mile of road.	No. of cars in daily operation.	Aver. daily mileage per car.	Average No. pass. daily per car.	Passengers carried per car mile	Operation expenses per car mile.	Operation expenses per car per day.	Cost per passenger carried.
	Of all tracks	Of road.								
1	51·0	35·0	*162,857	50	100	313	3·13	12·29	12·29	3·93
2	40·0	19·5	487,582	140	91	188	2·06	7·80	7·10	3 79
3	16·0	19·0	199,000	16	125	343	2·75	8 43	10·54	3·07
4	8·5	5·0	*460,000	20	83	318	3·82	11·82	9·80	3 09
5	15·5	14·0	167,511	18	106	357	3 35	11·00	11·70	3 28
6	28·0	23·5	286,852	31	108	597	5·51	12·74	13 76	3·31
7	3·8	2·8	200,000	5	92	307	3·33	8·49	7·81	2·55
	162·8	109·8	—	280	—	—	—	9·83	—	3·28

* Estimated.

Total annual car mileage, 9,862,000. Total number of passengers carried annually, 29,144,000.

Table I. shows that, taking street lengths as the unit of comparison, in the cases of the roads under consideration the total permanent investment of the electric roads is only 15 per cent. more than that of the horse roads, while the cable roads cost more than nine times as much as the electric roads. Table II. shows operating and interest expenses per car mile, and per passenger carried for each of the three systems.

OPERATING EXPENSES.

Average of 22 trolley roads. Length varying from three to 51 miles; cars in daily operation, three to 140; daily mileage per car, 80 to 150; average daily mileage per car 110.

Cost of coal varies from 1.00dol. per ton for slack, to 3.00dols. for "run of mine," and 3.80dols. for lump. Wages of conductors and motormen vary from 10 to 20 cents per hour. Consumption of coal varies from 4·3lb. of slack per car mile to 12·2lb. R.O.M. per car mile.

The station output varies from 3·7 e.h.p. to 8·4 e.h.p. per car in operation, for roads equipped with 16ft. cars and Edison motors. In the latter case the road had many heavy grades and sharp curves. One road, equipped with 30ft. double-truck cars (weight complete, about 10 tons), 6 Edison, and 14 short double 15-h.p. equipments, traffic medium and grades moderate, required an average of 10·7 e.h.p. per car in operation.

The best station performance is 1 e.h.p. for every 5lb. of slack or 4lb. of nut consumed; and evaporation of 7½lb. of water per pound of slack consumed. Return tubular boilers, Murphy furnaces, Armington and Sims high-speed, single-cylinder, non-condensing engines, and Edison generators are in use.

TABLE V.	Expenses per car mile (cents). Highest.	Lowest.	Average.
Maintenance of road-bed and track	1·86	·10	·54
Maintenance of line	·95	·01	·12
Maintenance of power plant, including repairs on engines, dynamos, buildings, etc.	·86	·05	·36
Cost of power, including fuel, wages of engineers, firemen, dynamo tenders, oil, waste, water, and other supplies...	4·95	·48	1·96
Repairs on cars and motors.........	5·24	·59	1·80
Transportation expenses, including wages of conductors, motormen, starters, and switchmen, removal of snow and ice, accidents to persons and property, etc.	9·47	2·74	4·98
General expenses, including salaries of officers and clerks, office expenses, advertising, printing, legal expenses, insurance, etc.	2·95	·79	1·26
Total	*22·99	*7·80	11·02

* Respectively the highest and lowest total for any one road.

DETAILED DISTRIBUTION OF OPERATING EXPENSES.

For roads of 10 or 15 miles and upward, operating 20 or more cars per day, averaging 105 to 110 miles each, grades moderate, a careful distribution of expenses, based upon the experience of the best roads, will average about as follows:

	Expenses per car mile (cents).	
Maintenance of road-bed and track....		·54
Maintenance of line......................		·12
Maintenance of power plant:		
Repairs on engines and boilers.....	·180	
Repairs on dynamos	·101	
Miscellaneous repairs	·078	·36
Cost of power:		
Fuel...................	·868	
Wages of engineers and firemen	·653	
Wages of dynamo tenders, etc...	·220	
Oil, waste, water, and other supplies................	·218	
		1·96
Maintenance of rolling-stock:		
Repairs on motors (ex. gearing)	·695	
Repairs on gearing and trolleys	·594	
Repairs on car bodies and trucks.................. ...	·512	
		1.80
Transportation expenses:		
Wages of conductors and motormen	4 262	
Wages of starters, switchmen, track sweepers, etc.	·268	
Cleaning and inspecting cars	·238	
Oil, waste, and other supplies	·083	
Accidents to persons and property..	·061	
Miscellaneous	·068	
		4.98
General expenses:		
Salaries of officers and clerks	·743	
Office expenses	·138	
Advertising and printing	·061	
Legal expenses...	·068	
Insurance	·161	
Miscellaneous	·091	
		1·26
Total		11·02

The paper closes with detail tables for seven roads shown in Table IV., which contains many interesting data.

WATT'S ELECTROLYTIC ZINC PROCESSES.

(Concluded from page 428.)

In treating calamine, or native carbonate of zinc, by this process, the ore, which does not require to be calcined, is crushed and ground to a fine powder, which is readily effected, and at little cost, by any of the well-known ore crushing and grinding machines, which have now been brought to a high state of perfection for purposes of this kind. It will be readily understood, as in all chemical operations in which a substance has to be separated from its insoluble associates by means of an acid or other solvent, that the process is not only hastened, but economised, by having the material to be operated upon in as fine a state of division as possible; and the trifling extra cost of reducing the material to a fine powder is fully compensated by the greater rapidity with which the solvent does its work, while at the same time there is infinitely less chance of waste of product than when the material to be operated upon is in a coarser or less finely-divided state. The percentage of zinc carbonate in the ore being previously ascertained, an equivalent proportion of dilute sulphuric (one part of the commercial acid to six parts of water) is introduced into a dissolving-tank, furnished with an agitating apparatus, and the finely-powdered ore is then added in small quantities at a time, care being taken to allow the bubbles of carbonic acid, which gas is liberated very copiously, to break and disperse after each addition of the material, otherwise the frothy matter formed will be liable to overflow. It is perhaps as well to state that the powdered ore should be introduced through a hopper placed over the opening of the tank, which should be fixed in close proximity to the furnace fires, so that the carbonic acid generated may be carried off into the flue of the chimney, or dispersed by other suitable means. Before the full quantity of ore has been put into the tank, the mixture should be tested from time to time to ascertain how nearly the acid approaches saturation, and when this point is nearly reached, the agitation should be allowed to proceed for some minutes without further addition of the powdered ore, and the contents again tested; if there be but a trifling evidence of acidity, the agitation may be sustained for a short time longer, and the agitator then stopped, and the contents of the tank allowed to rest until the sedimentary matters have well settled down. The clear liquid is afterwards run into a mixing-tank, in which it is fully prepared as the electrolyte by the addition of a solution of zinc acetate and sufficient water to reduce the liquid to the proper working strength—that is, having a specific gravity of about 1,130. The undissolved residuum is then washed, and the liquor treated as before described. To prepare the zinc acetate from the powdered calamine ore, a quantity of commercial acetic acid (about 15 per cent. real acid), equal to about 10 per cent. of the dilute sulphuric acid used in the former operation, is put into a smaller dissolving-tank, with agitator attached, which is set in motion and the powdered ore then gradually introduced from a hopper as before, and the agitation kept up briskly, not only while the ore is being introduced, but for some time after the previously calculated quantity has been put into the vat. As in the former case, the acid should be allowed sufficient time to act fully upon the zinc carbonate contained in the ore, and the agitation sustained so as to bring the powdered material well in contact with the said solvent. Acetic acid being a weaker solvent of the zinc carbonate than dilute sulphuric acid, it is a good plan when preparing the acetate solution to add a larger proportion of the powdered ore to the acetic acid than is actually required to neutralise it, and when the acetate of zinc has been removed, and the residuum washed as directed in the former paper, sufficient dilute sulphuric acid is then poured on to the undissolved ore with agitation, when the stronger acid liquor will readily dissolve out the zinc carbonate from the ore which was added in excess in the latter operation.

The resulting acetate and sulphate of zinc solutions are then transferred to the mixing-tank, together with the first wash liquors from the respective tanks, and the hydrometer is then used to ascertain the strength of the compound liquid, the weaker wash liquors being used when necessary to reduce the solution to the proper standard—that is, specific gravity 1,130 or thereabouts. It is assumed that all the zinc liquors have been tested to ascertain how far they have approached the neutral point, but, as before observed, a slight trace of acidity is not absolutely objectionable, as would be the case with a solution of the sulphate of zinc alone. The compound zinc solution, having been prepared in the mixing-tank as described, is allowed to rest for a few hours, to enable any insoluble matters accidentally present to subside; after which, the perfectly clear liquor is run into the electrolytic-tanks for the recovery of the zinc, or is pumped into the head supply-tank, by which the electrolytic-tanks are fed with fresh liquor, when the circulating system before referred to is set in motion.

In selecting zinc ores for treatment by this process, it is better to fix a standard percentage, based upon the actual metallic strength of the ore, so that the proportions of the acids used for dissolving the oxide or carbonate, as the case may be, may be readily arrived at without the trouble of close calculation. For example, if it be the rule to take 50 per cent. as the metallic strength of the ore, this can readily be arrived at by mixing certain proportions of the richer ores with those of a lower grade. Since some ores, and other zinc-yielding substances—as flue-dust, for example—are somewhat more freely attacked by the acids than others, owing to the finely-divided state of the zinc oxide or its carbonate (calamine), the coarser material (say, calcined blende) may be judiciously put into the dissolving-tank first, while the dilute acids are in their full strength, when the remainder of the charge, which may consist of powdered calamine or flue-dust, may then be gradually introduced until the entire charge of zinc material has been put into the dissolving-tank. If a system of this character be adopted, the subsequent results will be far more uniform, and the operations more effectually simplified, than if the ores were to be used somewhat indiscriminately. Where, however, one class of ore only is from necessity the product from which the zinc has to be extracted, samples of the ore from different parts of the same mine should be examined, and if there be any considerable difference in the percentage of zinc, a fair average should be arrived at to secure as great a uniformity as possible before the calcined and powdered ore is placed in the dissolving-tanks. It sometimes happens that low-grade ores can be obtained at advantageous prices, in which case a certain percentage of such ores may be worked in with those of higher quality, but the actual percentage of the inferior material which may be employed in this way can only be determined by actual practice; it would be prudent, however, to commence with a moderate proportion (say 10 per cent.) of the lower-grade ore at first, gradually increasing the proportion until a standard figure has been reached. Respecting the ores known as "bluestone ores," which contain, besides zinc, considerable percentages of lead, as, also, frequently both silver and gold, there is one serious difficulty to contend with, which is that there appears to be no practical means of expelling the sulphur by ordinary calcination or roasting. Indeed, some of these ores do not appear to be much affected by any modification of the heat during the process of roasting. When it is desired to utilise a certain proportion of bluestone ore in combination with a larger proportion of, say, blende, the best way appears to be to use about 10 per cent. of the refractory ore, reduced to fine powder, with about 90 per cent. of blende, also in fine powder, and to calcine the mixture with free contact of the air, using a dull red heat at first, otherwise the material is very apt to fuse, and the heat may be gradually increased after a time, but should not be allowed to exceed moderate redness. The roasting should be kept up for at least a couple of hours, during which time the material should have been repeatedly turned over, so as to bring the hotter portions to the surface to assist its oxidation by the air. The mixed ore, when thus calcined, may then be treated in the same way as roasted blende for dissolving out the oxides lead and zinc formed. It will be necessary, however, to first treat the ore with acetic acid, as before described, to dissolve out the lead, and, after washing the residuum, to treat the remaining mass with dilute sulphuric acid. The lead is then thrown out of the acetate solution by scrap zinc, and the two solutions afterwards mixed to form the electrolyte for the recovery of the zinc.

During the electrolysis of the zinc solution the partially-exhausted and acid liquors are allowed to flow into receiving-tanks; these liquors are afterwards neutralised by being agitated in contact with calcined ore (if blende) in fine powder, or with powdered calamine. Respecting this part of the electrolytic process, the question has often been asked, "Will the comparatively weak acid liquor of the baths act with sufficient energy upon the ore as to become again saturated with zinc within a reasonable time?" To this query the following reply may be given with perfect confidence as the result of actual trial, conducted with the special object of deciding the point once for all: Finely-powdered ore (blende) being used, and agitation kept up continuously, the acid liquor of the zinc bath became neutral to litmus paper in half an hour. This satisfactory result shows not alone that the zinc oxide is readily attacked by the weak acid, but also that the time occupied in the recuperation of the partially-exhausted solution is in reality remarkably brief. Moreover, as the particles of undissolved ore and gangue very quickly subside, the renovated solution is ready to be again pumped into the head supply tank after a few hours' rest. A moderate stock of the normal zinc solution being always kept on hand, the revivified liquors take their place in due course, and there is no break, therefore, in the continuity of the manufacture.

When the electrolytic production of zinc by this process involves the employment of ores containing a good deal of lead—which it is always important to recover as a profit-bearing by-product—the best method of securing the lead is to keep a stock quantity of commercial acetic acid (15 per cent.) specially for the purpose of dissolving the oxide of lead from the calcined ore as the first operation. It is also advisable to have a small auxiliary plant, consisting of several tanks fitted with carbon anodes, suspending rods, etc., for the purpose of depositing zinc from its acetate solution. This arrangement being provided, the ore containing lead is first treated with a sufficient quantity of acetic acid to dissolve out the whole of the lead oxide, a certain portion of zinc oxide also becoming dissolved. When the resulting acetate liquor is treated with scrap zinc as before, and when the whole of the lead is precipitated, and the solution quite clear, it is transferred to the auxiliary tanks, and as much of the zinc as possible deposited from the solution upon plates of sheet zinc or other suitable metal. When the reduction of the zinc from the acetate solution has proceeded as far as may be practicable, the strongly-acid liquor which results is again used as a solvent for the lead in other batches of ore, and so on, the acetate solution thus obtained being in each case first deprived of its lead by precipitation, and the resulting solution of acetate of zinc then electrolysed for the recovery of its zinc, or as much thereof as can be obtained without disadvantage to the electrical and other conditions of the arrangement. The object of the method suggested is to employ a certain amount of acetic acid over and over again for dissolving lead from the zinc ores, the zinc used in throwing the lead out of its solution being afterwards recovered by electrolysis, leaving a considerable portion of free acetic acid in combination with a reduced percentage of zinc acetate, to be again used as a solvent for lead oxide as before. After each employment of the acid liquor in the way described, the solution obtained is drained from the ore as fully as possible, and the ore is then washed to remove the lead-zinc liquor remaining in contact with it; the wash waters may be concentrated by any of the well-known evaporators, and the lead therein afterwards precipitated as before, when the zinc acetate liquor may be added to the bath of the solution used in this operation.

Separation of the Zinc from "Hard Spelter."—The substance known as "hard spelter"—hard zinc—or "dross," is a product of the galvanised iron works, and contains, in addition to the impurities of the spelter, from which it takes its origin, varying percentages of iron, with which the zinc becomes alloyed in the process of "galvanising" iron goods of various kinds. The zinc contained in this material may, however, be very readily and economically extracted by the process which forms the subject of these papers—a brief outline of the procedure being as follows: For the convenience of immediate use, and to save the necessity of remelting, the waste product, or "dross," may be withdrawn from the galvanising-baths and poured into specially-prepared ingot moulds, to form plates of convenient size for anodes; the plates may be cast with "lugs" for connecting them to the conducting-rods of an electrolytic bath, or series of baths. The electrolyte for extracting the zinc from the impure spelter consists of a mixed solution composed of zinc acetate and sulphate, the former in the proportion of about 10 per cent. of the latter, the density of the mixture being about specific gravity 1,120 to 1,130. The impure zinc anodes being suspended from their supporting rods, cathodes of thin sheet zinc may be used as the negative electrodes. A current of about four amperes per square foot of cathode surface, at a pressure of ·5 volt, gives a very prompt deposit in the above solution, the metal depositing of a very fine colour, and nearly white. When the bath has been at work under these conditions a short time, it is found that peroxide of iron of a yellow or ochreous colour forms at the anodes, which gradually falls to the bottom of the bath, while at the same time oxygen bubbles become evolved at these electrodes. No hydrogen is given off at the cathodes. When testing the solution from time to time, even after it had been worked off and on during a period of many months, no trace of iron whatever was found in the liquid; indeed, the presence of oxygen at the positive plates would indicate that this metal would be oxidised as soon as its particles became exposed by the removal of the zinc with which it was loosely alloyed in the impure metal. When separating the zinc from hard spelter by this process, it has repeatedly been found that the full theoretical quantity has been deposited per ampere-hour, which is another proof of the excellence of the aceto-sulphate of zinc as an electrolyte for the deposition of the metal. The low E.M.F. required to pass the most suitable current which can be used for the purpose in view, points to the fact that the process is an economic one; indeed, this has been repeatedly verified by long and continuous trials, and those who are interested in the utilisation of hard spelter as a source of very pure zinc will find that the process, of which the foregoing sketch will give an approximate idea, is such a one as may be investigated without much fear of disappointment.

Respecting the recovery of any silver or gold which may be known to exist in the ore, these may be readily separated from the still moist residues by any of the well-known processes which are employed for the purpose, but it is advisable that the residues of such ores should be kept apart from those in which the precious metals do not form a constituent; by carefully observing this precaution the gangues containing silver and gold will be more amenable to the treatment for the recovery of those metals, since their bulk, which has become greatly reduced by the removal of the zinc (and lead) therefrom, will not be increased by the admixture of less valuable material.

ROYAL SCOTTISH SOCIETY OF ARTS.

The first meeting of the seventy-first session of the Royal Scottish Society of Arts was held on Monday in the Society's Hall, 117, George-street, Edinburgh.

The Right Honourable **Lord Kingsburgh**, president of the society, occupied the chair, and, in opening the proceedings, recounted some of the things which had come to his notice on the occasion of a visit to the electrical exhibition at Frankfort. The exhibition had struck him very forcibly, in respect of the evident confidence of those who had capital invested, for the manufacture of articles for the application of electrical science, that it would pay them very well to go to the great expense of advertising at that exhibition. This had struck him particularly in regard to the exhibit of the great German electricians, Messrs. Siemens and Halske. It was hardly credible that that firm had spent £60,000 upon their installation, and that they had on the ground 60 men, of whom 12 were engineers. He had been struck with the way in which the art development of electricity was shown in the wonderful reproduction in shining metal of beautiful natural objects, such as feathers, spray, leaves, etc., the whole art being applied by the electricity itself. The splendidly-built machines, both electrical and steam, were a striking feature of the exhibition. One of these, a dynamo for showing the power of enormous currents, was exhibited to him in the Siemens-Halske collection. The engineer placed a sheet of ebonite between the terminals, and they could see the electrical energy playing on each side of the ebonite seeking to make a connection, till at length, like two tongues, it met over the top, and a series of incandescent lamps in the circuit were lighted up. The current was driven at that time at 20,000 volts, but learned afterwards that it had been driven up to as much as 48,000 volts. Most striking of all, perhaps, as regards the large working system, was the transferred power from Lauffen to Frankfort, and it certainly made one's hair stand on end to have pointed out suspended overhead the two naked wires carrying such an enormous power. He questioned whether in this country they would have permitted the experimentors to set it up. It would give them some idea of the power transmitted from Lauffen when he told them that one of the exhibits was a device in incandescent lamps as large as the area of the hall in which they were seated, 30ft. by 60ft., which was lighted from Lauffen. One word which he must say for our German friends, which implied a rebuke to the scientific men in this country, was that of three gentlemen from whom he had got information regarding the Siemens and Halske's exhibit, two spoke English as well as any Englishman. He very much feared that if a German speaking no English had come over to the Edinburgh Electrical Exhibition he would have found it more difficult to obtain information. He thought the sooner we learned the lesson the better, that those nations who in their scientific and business men could meet the scientific and business men of other nations and speak to them their own language, would be sure of absorbing a great amount of the commercial prosperity and of scientific success, which we were just as capable of doing if we would only realise that the English language was not quite good enough to carry us all over the world.

On the motion of **Mr. Bruce Peebles**, seconded by **Mr. F. Grant Ogilvy**, Lord Kingsburgh was thanked for his address.

The **President** then presented to the winners the society's prizes for papers read during the last session.

Office bearers were elected for the ensuing year. Mr. Alexander Leslie, C.E., was elected president; Mr. W. B. Blaikie and Mr. C. A. Stevenson, C.E., were elected vice-presidents; Mr. W. A. Carter, C.E., was re-elected secretary; and Mr. C. W. W. Thomson, C.A., treasurer.

LEGAL INTELLIGENCE.

IN RE THE CADOGAN ELECTRIC LIGHT COMPANY.

Petitions for Winding-up.

Two petitions for the winding-up of this company, which is in voluntary liquidation, came before Mr. Justice Kekewich on Saturday.

Mr Warmington, Q.C., and **Mr. Alexander Young** appeared for the first petitioner, and asked for a supervision order.

Mr. Vernon Smith, for the second petitioner, pressed for a compulsory order, and asked that the carriage of the winding-up might be given to the second petitioner.

Mr. Waggett, for the liquidator, strongly opposed a compulsory order, and submitted, subject to the discretion of the Court, that no case was shown for a supervision order.

Mr. Justice Kekewich said that the case was not one in which there was any suggestion of fraud or matter of that kind requiring that the case should be placed in the hands of the Official Receiver. All that was needed was the protection of creditors. It was intended to hand over this company's assets and business to a new company already formed, and in the carrying out of a transaction of that kind difficulties occurred in a compulsory winding-up which were not encountered in a voluntary liquidation. On the other hand, the case appeared to be one in which the rights of creditors might be prejudiced by a voluntary winding-up, if the liquidator spent the assets in carrying on the business and making fresh installations which would have to be paid for in ready money. His Lordship therefore made the usual supervision order on the first petition, and made no order on the second petition.

UNIACKE v. SCOTT.—SCOTT v. UNIACKE.

An Apprenticeship Question.

This case came before Mr. Justice Romer, in the Chancery Division of the High Court of Justice, on Thursday, the 5th inst.

Mrs. Mary Augusta Uniacke, the plaintiff, is a widow, and on the 19th of December, 1889, she, her son, F. W. P. Uniacke, and the defendant, Mr. Ronald Augustus Scott, of Acton-hill, an electrical engineer, executed in duplicate a deed by which F. W. P. Uniacke was apprenticed to the defendant for three years from the 25th of December, 1889, agreeing to serve and not unlawfully absent himself, etc. By the same deed the defendant, in consideration of a premium of £150, agreed to receive Uniacke as an outdoor apprentice in the art of an electrical engineer, providing the apprentice should "serve his master faithfully and well and in accordance with the rules and regulations of this establishment," and to pay him 7s. 6d. per week during the first year, 10s. per week during the second year, and 15s. per week during the third year. The plaintiff alleged that the defendant had committed various breaches of the agreements on his part contained in the deed, and in particular, *inter alia* (1) that he had not at any time properly taught or instructed F. W. P. Uniacke, or caused him to be properly taught or instructed, in the art or business of an electrical engineer; (2) that the defendant in September, 1890, without due cause, suspended F. W. P. Uniacke from attending, and refused to allow him to attend at the workshops and place of business of the defendant for one month; (3) that the defendant had discharged F. W. P. Uniacke. The plaintiff accordingly claimed a return of the premium, or, in the alternative, damages. The defendant denied that he had discharged the plaintiff, or been faithfully served by him, and alleged that the suspension was in accordance with the rules and regulations exhibited in conspicuous parts on the works; that the apprentice had repeatedly and without leave absented himself from the workshops, and when there had been very negligent. The defendant also alleged that the plaintiff had admitted that her son's heart was not in the work, and that both he and his mother were anxious that he should be discharged from his apprenticeship, and, without alleging any breach on the defendant's part, had requested the defendant to cancel the indenture. The defendant also denied any breaches on his part of his agreement to instruct, and counterclaimed, in repect of alleged breaches by the apprentice, for the sum of £50 as damages. The effect of the evidence is sufficiently stated in the judgment of his Lordship. The letter of the 27th of October referred to in the judgment was as follows: "Dear Sir,—As you have known for some time now that I do not care for electrical engineering, I am writing to you to beg you to cancel my indentures. I have no fault to find with the works, but it was a mistake on my part ever to have tried electrical engineering. I trust that under the circumstances you will consent to return a reasonable portion of my premium.—I remain, truly yours, FRANCIS UNIACKE."

Mr. Neville, Q.C., and Mr. J. W. Baines were for the plaintiff, and Mr. Haldane, Q.C., and Mr. H. Terrell were for the defendant.

Mr. Justice Romer, in giving judgment for the plaintiff, said the defendant's business was somewhat peculiar. He had very few, apparently only seven or eight, workmen, properly so called, and a great number of pupils and apprentices. There were about 65 apprentices now, and at the date of the apprenticeship deed there were about 40. But his Lordship was not concerned with the question whether the defendant had taken too many pupils. It might be that he, nevertheless, did his duty to this particular pupil, and, even if he had not too many pupils, he might, nevertheless, have neglected his duty to this one. But the great number of pupils probably accounted for the neglect shown here. As to the first breach of duty alleged, his Lordship had to consider whether the defendant did commit a breach by not teaching and instructing the plaintiff's son. His Lordship had heard the evidence, and was very unfavourably impressed by the evidence of the defendant and his witnesses. The plaintiff's son, whatever little failings he might have, appeared to be a truthful young man, and his evidence, where there was a discrepancy, was to be preferred to that on the other side. His Lordship was convinced that the son was not taught, or attempted to be taught, to any substantial extent, the art of an electrical engineer. He was only employed in handy work, which saved the whole or part of a workman's wages. For nine months he had been kept at two sorts of work only—viz., filing and fitting brass rods, and attending to a machine for making brass screws. No real instruction in electrical engineering had been given at all. One of the defendant's witnesses said Mr. Uniacke had been put on a lathe, but the apprentice denied this, and probably the defendant's witness had been misled by the fact of there being so many pupils. His Lordship quite agreed that in teaching the art of electrical engineering it might be very useful that a pupil should know something of the elements of the machinery and the articles used in the business, but that might be carried too far. There must be a limit to keeping the pupil to the elements of the business. The defendant was not justified in keeping the plaintiff's son for nine months at the mechanical work referred to. The son appeared to have been taught nothing. The defendant appeared to have left the business to his manager, and the manager to the foreman, and the foreman seemed to have looked on the pupil only as a person employed to do mechanical work. His Lordship held on the facts that the defendant had wholly neglected his duty, and was not surprised that the apprentice had disliked the work and been inattentive. He had been somewhat inattentive—principally by his absences, some of which had been caused by illness. But the inattention on his part had been grossly exaggerated. The defendant could not complain of this, having regard to his own neglect. No conduct of the plaintiff's son justified the defendant in his breaches of the apprenticeship deed. It was suggested by the defendant's witnesses that the plaintiff's son could not be taught this business, but, without attributing to him extraordinary ability, his Lordship was satisfied of his general intelligence. Under these circumstances the plaintiff's son became dissatisfied, and it was not surprising that his mother thought he had no heart for the business, and tried to get the deed cancelled, and obtain a return of part of the premium. After she had gone to India, the son's salary was reduced by the foreman, for some inattention, by 25 per cent. That was an ample punishment; but, on the son complaining to the defendant, and merely because of such complaint, the defendant, not contenting himself with confirming what the foreman had done, suspended the son for a whole month, such suspension meaning that the son was not allowed to come to the works or receive any salary or instruction. That decision was unjustifiable. The defendant sought to justify it by referring to his rules and regulations. They were not brought to the attention of the plaintiff's son, if they were in existence at the date of the deed, or for some months afterwards. But the deed meant the rules and regulations for the time being, and the defendant might make reasonable rules and regulations. Nevertheless, a rule that for neglect an apprentice might be suspended for three months was unreasonable. At any rate suspension for a month in this case was unreasonable, and could not be relied on by the defendant. Under the circumstances the defendant had done what amounted to grave breaches, entitling the plaintiff to sue for damages, on the double ground of the entire neglect of the defendant in doing his duty to the plaintiff's son, and his breach of duty by refusing to instruct him. The breaches were so grave that it would be unreasonable to suppose that the plaintiff was bound to send her son back for the remainder of the term, and it would be absurd to say that she was still bound to treat the deed as not having been broken and practically put an end to by the defendant. His Lordship was also dissatisfied with the defendant's conduct in another matter. There was a complaint on October 24 of his neglect to teach the art of electrical engineering. The defendant, finding he was complained of for neglect of duty, suggested to the plaintiff's son that he should write the defendant a letter saying that he had no complaint to make of the defendant's works, and represented to him, or induced him to believe, that on such a letter being written a portion of the premium would be returned. The plaintiff's son accordingly wrote the letter of October 27, and the defendant had admitted that when he suggested this letter he had no intention to return any part of the premium. His Lordship considered this a mere trick to get an acknowledgement that the apprentice had no fault to find with the works, and so defeat any claim for neglect of duty on the defendant's part. His Lordship was not surprised that the son wrote the letter, or that such letter was not stopped by the solicitor who was consulted by him; but that letter would not avail the defendant in this Court, which could still look at the true facts. His Lordship was satisfied that there had been a total neglect of the defendant's duty. When the plaintiff returned from India she found that her son was no longer at the works of the defendant, who had acceded to her son's request that until his mother returned he should not be obliged to attend the works at all. The mother was justified in bringing the action, and was not obliged further to treat the deed as compelling her to send her son to work. The plaintiff was entitled, not to a return of premium, but to damages, which his Lordship assessed at £120. The defendant must also pay the costs of the action, and his counterclaim would be dismissed with costs.—*The Times.*

COMPANIES' MEETINGS.

CITY OF LONDON ELECTRIC LIGHTING COMPANY.

The following report of an extraordinary general meeting of this Company, held at Winchester House, Old Broad-street, on Thursday, the 5th November, 1891, at 3 p.m., has been supplied to us by the secretary.

Sir David Salomons, Bart., was in the chair.

The **Secretary** (Mr. J. Cecil Bull) having read the notice convening the meeting, the following resolution was proposed by the Chairman, seconded by the Earl of Suffolk, and carried unanimously: "That the special resolution which was passed at the ordinary general meeting of the Company held on the 15th day of October, 1891, as follows: 'That article No. 13 of the Company's articles of association be altered by inserting after the words, "each call," at the end of the fourth line, the following: "and that no call shall exceed one-fifth of the nominal amount of a share or be made payable within two months after the last preceding call was payable,"' be and is hereby confirmed."

The **Chairman** intimated that this really concluded the business of the meeting, but before separating he would like to say a few words in answer to an assertion he had seen in certain newspapers that he had conveyed an entirely erroneous impression as to the relative cost of gas and electricity. He said: I will first state that an 8-c.p. glow lamp is usually taken to replace a 5ft. gas burner at usual gas pressure, the light in each case being approximately equal. Again, an 8-c.p. lamp requires from 30 to 33 watt-hours—*i.e.*, ampere × volt hours, and as a Board of Trade unit equals 1,000 amperes × volt hours, it consequently results that at 8d. per Board of Trade unit the cost comes out that 33 8-c.p lamps for one hour cost 8d., if the value of the lamps is excluded. Thus: $\frac{1,000}{33}$ = 33 lamps, 8 c.p., for one hour, for 8d. Now glow lamps last over 1,000 hours before renewal, say 1,000 hours in this case, and each lamp costs 3s. 6d., or 168 farthings; then cost of wear of 33 lamps for one hour is $\frac{168}{1,000} \times 33 = 6$ farthings = 1½d.; consequently cost of one Board of Trade unit becomes 9½d. when wear of lamp is taken into account. One 8-c.p. lamp for one hour = $\frac{9½\text{d.}}{33}$ = 1·15 farthings = 1⅛ farthings. Gas being reckoned by price per 1,000 cubic feet, a foot burner consumes $\frac{5}{1,000} = \frac{1}{200}$ of charged price per 100 cubic feet. Consequently, with gas at 2s. 6d. per 1,000 cubic feet, a 5ft. burner costs per hour $\frac{1}{200} \times$ 2s. 6d. = $\frac{120}{200}$ farthings = $\frac{3}{5}$ = 0·6 farthing. Gas at 3s. per 1,000 cubic feet by a similar calculation = $\frac{1}{200} \times$ 3s. = $\frac{144}{200}$ farthings = 0·7 farthing. Gas at 3s. 6d. per 1,000 cubic feet similarly = $\frac{1}{200} \times$ 3s. 6d. = $\frac{168}{200}$ farthings = 0·84 farthing. Gas at 4s. 6d. per 1,000 cubic feet also by same method = $\frac{1}{200} \times$ 4s. 6d. = $\frac{216}{200}$ farthings = 1·08 farthings. Gas at 5s. per one 5ft. burner for one hour costs $\frac{1}{200} \times$ 5s. = $\frac{240}{200}$ farthings = 1·2 farthings. Consequently, the electric light in point of cost lies between gas at 1,000 cubic feet 4s. 6d. and 5s. The actual value being over 4s. 10½d. and under 4s. 11¼d.

No questions being asked, the meeting then terminated.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.

The ordinary general meeting of this Company was held at Winchester House on Thursday morning, Mr. W. S. Andrews (chairman) presiding.

In moving the adoption of the report (*vide* our last issue), the **Chairman** announced with regret the retirement of Mr. Henry Weaver from the Board, he deeming that there were some incompatibilities in his holding a position there. Having alluded in complimentary terms to Mr. Weaver's abilities, and the service he had rendered to the Company, the Chairman reviewed the chief items in the accounts, and then passed on to deal with the competition with which the Company is threatened. One competing line had been established, and the cable opened for traffic. It was to connect North America and Brazil, but at present stopped at Santos and Cuba. It was opened on the 1st September, and had not affected their traffic at all. On the 22nd October this cable was interrupted, and the interruption still existed. As far as they could see there was no immediate prospect of a repair being effected. Owing to the termination of the Chilian war, their old competition with the West Coast Company had again come into operation. They could not very well estimate the effect of this. The only guide was their receipts. Of late their receipts had been lower than during the corresponding period of last year, but then there was the anomaly that their business was actually larger. This was due to the low rate of exchange. Another competing line was talked about, and some people said that the cable was being made, whilst others said that it was not. People connected with new companies did not always see the very great difficulties they were going to encounter, and what with syndicates and one thing and another several companies were raised up where one would suffice. The competing cables were all single lines, so that if they broke there was no means of communication at all. In this respect the other companies were at a disadvantage with the Western and Brazilian, whose cables were duplicated. The efforts of the Brazilian Submarine and themselves had been directed towards careful preparation for this competition, and there was no doubt that with their skilled and adequate staff, their loop cables, duplex apparatus, and the fact of the loop of their system being the core line with Brazil, any competing cables would have their work cut out. His own impression was that the Western would be able to hold its own. They were not going to bully these people. They were not going to lose their temper or get flurried; but they believed that if they provided for the future and established their system on the best possible footing, with their experience, knowledge, and connection they ought at least to do considerably better than these gentlemen who were going forward knowing nothing about the business, and with single cables. Since the last meeting they had acquired the Montevidean Telegraph Company's business for a payment in shares. Previous to this purchase this Company held a charge upon the Western's revenue, and now they had substituted dividend-earning shares for that charge. This gave them increased strength. Owing to the competing lines they had ceased publishing their traffic receipts.

The resolution was seconded by **Mr. Earle**, and after a few questions had been asked and answered, was carried unanimously.

COMPANIES' REPORTS.

WOODHOUSE AND RAWSON UNITED, LIMITED.

Directors; Sir Rawson W. Rawson, K.C.M.G., C.B. (chairman); the Right Hon. Sir Edward Thornton, G.C.B.; Samuel Pope, Esq., Q.C.; Philip Rawson, Esq., J.P.; Sir John Stokes, K.C.B.; Frederick L. Rawson, Esq. (managing director).

Annual report to be presented to the shareholders at the general meeting at Cannon-street Hotel on November 13, at 12 o'clock.

The Directors present herewith to their shareholders the report and balance-sheet for the past year. Of the second issue of capital authorised at the last general meeting—namely, 20,000 ordinary shares, 10,000 preference shares, and 100,000 £5½ debenture stock, 9,889 ordinary shares, 7,000 preference and £85,192 debenture stock have been allotted. The balance-sheet shows a net profit of £35,103. 9s. 2d., which, with the sum of £16,335. 15s. 3d., the amount brought forward from last year, makes a total of £51,439. 4s. 5d. Out of this sum the Directors paid in February last an interim dividend at the rate of 8 per cent. upon the preference shares, and 15 per cent. upon the ordinary shares, and they now recommend a further dividend up to the 30th June last at the same rates. These payments will absorb the sum of £30,507. 16s., and leave the sum of £20,931. 8s. 5d. Out of this balance the Directors recommend the appropriation of £10,000 to the reserve fund, which will then stand at £35,000, £1,500 to bad debt reserve, and the addition of £500 to the employés pension fund, bringing this up, with interest, to £1,565, and leaving £8,931. 8s. 5d. to be carried forward to the current year's account. With a view of enabling the balance-sheet to be prepared up to as late a date as possible, the accounts for all the branches are made up to May 31, stock being taken to that date, whereas the head office accounts are made up to July 31.

West Kensington Hall, Hammersmith.—During the last year these works have been increased by the erection of a new large factory 133ft. by 44ft. and five storeys high, fitted with all the latest appliances. The old engines and boilers have been replaced by those of the latest and most efficient type, the old chimney has been pulled down and a large one erected, whilst the foundry has been enlarged and the works generally improved. The cost of the new buildings has been put to capital account, whilst of the cost of moving, £2,000 has been written off revenue account. Although alterations have not been carried out without considerable interruption of the work in hand, the turnover has largely increased, and it is hoped that this extension will enable the Company satisfactorily to keep pace with the work offered in this department. The power for the whole of the new factory is transmitted by electric motors placed on the different floors. One of the Company's buildings has been fitted up for the manufacture of the Epstein accumulator, one of the inventions mentioned in the report of last year as being tested, and which has more than borne out the expectations that had been formed of it.

Union Foundry at Kidsgrove.—These works have been consolidated, a new boiler shop erected, and new plant put down. The mortgage which was existing on the property when it was taken over has been substantially reduced. The vorks are at present very busy, and there is every prospect of a considerable development of trade in the future. An extension of this branch has been made by the acquisition of the business of Messrs. Anderson and Gallwey, hydraulic engineers, for whom the Company has been manufacturing, and who have a large number of specialties in hydraulic machinery now taken over by the Company. Mr. Gallwey remains with the Company as manager of this department. The patents of Mr. Reginald Bolton for electric cranes and winches have also been purchased, and promise to bring in a considerable amount of valuable business.

Cornbrook Telegraph Works.—These works at Manchester have been extended by the erection of special plant for the manufacture of dynamos and motors, the works having had a difficulty in supplying the orders in hand.

Supply Department.—This important department has continued to increase rapidly, the turnover for the last year having considerably exceeded that of the previous year, and the net profit has doubled. The increase has been such as to necessitate a wharf being leased for the heavier goods—viz., Lyon's Wharf, Thames-street, E.C. This increase since the date of the balance-sheet has been maintained. The acquisition of the new warehouse and show-room is giving satisfactory results.

Installation Department.—A large number of contracts have been carried out, and at the present time the amount of work in hand is larger than at any previous period. Amongst the contracts at present in hand is one for the erection of electric lighting plant for public lighting in the streets of Johannesberg. The central station plant supplied by the Company for Barcelona is working thoroughly satisfactorily.

Bradford Branch.—This portion of the business, from whence the installation work in Yorkshire is carried out, has given progressive results, and the supply of goods in the North is now being dealt with from that centre.

With regard to the department for testing and proving of new patents and inventions, to which your Directors drew attention in their last report, and at the general meeting, as likely to add materially to the profits, a large amount of business has been offered and examined. Out of the four important electrical inventions undergoing process of testing mentioned in the previous report, only one has turned out sufficiently well to justify this Company in introducing it to the public, this being the Epstein accumulator, to acquire and develop which the Epstein Electric Accumulator Company, Limited, has been formed, with Mr. Epstein as managing director, and from which this Company looks for important pecuniary results. Out of other new business in course of investigation by your officials one, after close examination by your Managing Director, has turned out satisfactorily, and gives promise, on introduction by your Company at an early date, to command great attention. The Directors feel themselves justified in alluding to the various Elmore copper depositing companies that have been introduced to the public under the auspices of your Company. As the technical statements made have been proved by actual results, your Directors not only believe that the several companies will fulfil the expectations held out by us, but will exceed them, and they have therefore entertained proposals for a further development of the process in other countries at an early date. The sum of £75,000, lodged by Woodhouse and Rawson, Limited, with this Company as guarantee fund for the payment of a minimum dividend of 15 per cent. per annum up to the 30th June next, has been repaid that company under the authorisation given to that effect at the last general meeting. Under the articles two directors retire, Mr. Samuel Pope, Q.C., and Mr. Philip Rawson, who, being eligible, offer themselves for re-election. The auditors, Messrs. Pixley and Co. (now Messrs. Jackson, Pixley, Husey, and Co.), retire according to the articles, and offer themselves for re-election.

BALANCE-SHEET, JULY 31, 1891.

Dr.	£	s.	d.	£	s.	d.
Share capital authorised—						
60,000 ordinary shares of £5 each	300,000	0	0			
50,000 preference shares of £5 each	250,000	0	0			
	550,000	0	0			
Share capital issued—						
Ordinary shares of £5 each :						
34,355—£2. 10s. called up	85,887	10	0			
15,531—fully paid	77,655	0	0			
				163,542	10	0
Preference shares of £5 each—37,053 fully paid				185,265	0	0
6 per cent. mortgage debentures of £100 each fully paid				65,500	0	0
5½ per cent. debenture stock				85,192	0	0
Mortgages on freehold property				23,500	0	0
Sundry creditors, May 31				40,544	4	9
Reserve fund				25,000	0	0
Pension fund				1,065	0	0
Profit, as per profit and loss account	£51,439	4	5			
Less interim dividend paid	14,464	16	0			
				36,974	8	5
				£626,583	3	2

Cr.	£	s.	d.	£	s.	d.
Freehold premises, West Kensington Hall, London, and Union Foundry, near Crewe, less depreciation				65,131	9	6
Leasehold premises at 88, Queen Victoria-street, 34, Cannon-street, Cornbrook Telegraph Works, Manchester; Bradford, and expenditure thereon				3,316	14	7
Plant, machinery and tools, at London, Manchester, Kidsgrove, and Chiswick Works, and at Bradford, less depreciation				31,392	12	2
Stock (finished and unfinished) and merchandise at works, depôts, warehouses, and branches, by valuation	£93,704	17	10			
Goods in transit	895	1	7			
Expenditure on contracts in hand and remittances to branches	31,466	13	4			
				126,066	12	9
Moiety special expenditure on advertising, repayable by instalments				3,425	0	0
Patents, patent rights, etc.				76,328	0	0
Goodwill				98,080	3	5
Sundry debtors 31st May				91 059	0	10
Due on calls				605	10	0
Bills receivable				4,432	15	2
Cash at bankers and in hand 31st May	£5,516	13	8			
Difference between receipts and payments, 1st June to 31st July	472	11	8			
				5,989	5	4
Sundry investments				119,338	15	0
Office furniture, fittings, etc.				1,417	1	5
				£626,583	3	2

PROFIT AND LOSS ACCOUNT FOR THE YEAR ENDING JULY 31, 1891.

Dr.	£	s.	d.
Salaries	15,208	8	8
Postages and parcels post	979	7	5
Stationery, printing, and catalogues	1,138	19	1
Travelling expenses	1,367	13	7
Rents, rates, insurance, etc.	2,993	16	1
Advertising and exhibition expenses	4,476	0	10
Legal and professional charges	1,921	8	2
Royalties and patent fees	2,467	7	9
Directors' fees	2,166	13	4
Furniture and fixtures depreciation account	354	13	2
Debenture interest from dates of payment to July 31, 1891	7,366	13	9
Written off patents, patent rights account	4,156	19	9
Income tax for 1890 and 1891	3,182	16	6
Mortgage debentures redemption account	1,030	0	0
Preliminary expenses	3,260	8	10
Cadby Hall removal	2,000	0	0
Profit carried to balance-sheet	51,439	4	5
	£105,510	11	4

Cr.	£	s.	d.
Brought forward from previous year	16,335	15	3
Gross profit	74,568	14	0
Balance of interest on loans and investments	8,262	5	6
Balance of discount account	913	12	5
Rent	1,497	1	8
Premium on shares, transfer fees, etc.	3,933	2	6
	£105,510	11	4

PROPOSED APPROPRIATION ACCOUNT.

Dr.	£	s.	d.
Interim dividend already paid for the first half-year at the rate of 8 per cent. per annum on the preference shares and 15 per cent. per annum on the ordinary shares	14,464	16	0
Proposed dividend for the second half-year at the rate of 8 per cent. per annum on the preference shares and 15 per cent. per annum on the ordinary shares	16,043	0	
Reserve fund	10,000	0	0
Bad debt reserve	1,500	0	0
Employés pension fund	500	0	0
Carried forward to new profit and loss account	8,931	8	5
	£51,439	4	5

Cr.	£	s.	d.
Net profit as per profit and loss account	51,439	4	5
	£51,439	4	5

WEST INDIA AND PANAMA TELEGRAPH COMPANY.

The report of the Directors for the half-year ended June 30 states that the amount to credit of revenue is £47,641, against

£52,351, the expenses being £24,868, against £26,669, leaving a balance of £22,773, which, with £668 brought over, makes a total of £23,441. Of this sum the Directors have placed £2,000 to reserve, leaving an available balance of £21,441, out of which it is proposed to pay dividends on the first and second preference shares of 6s. in each case, and one on the ordinary shares of 1s. per share, tax free, £5,255 being carried forward.

NEW COMPANIES REGISTERED.

Bicester Electricity Supply Company, Limited.—Registered by Indermaur, Clark, and Parker, 1, Devonshire-terrace, Portland-place, W., with a capital of £5,000 in £5 shares. Object: to carry on at Bicester the business of an electricity supply company in all its branches; also as electricians generally, mechanical engineers, etc. Registered without articles.

Globe Electric Company, Limited.—Registered by Gover and Chiles, 71, Queen-street, Cheapside, with a capital of £10,000 in £1 shares. Object: to acquire electrical and mechanical engineering businesses of all kinds, including chemical engineering, and generally to develop and work the same.

CITY NOTES.

West Coast of America Telegraph Company.—The receipts for October were £3,000.

City and South London Railway.—The receipts for the week ending November 8 were £783, as compared with £802 for the week ending November 1.

Weymersch Syndicate.—Mr. Joseph Pyke, director of the London Electric Supply Corporation, has joined the board of the Weymersch Electric Battery Syndicate.

West India and Panama Telegraph Company.—The estimated receipts for the half-month ended 31st October are £1,990, as compared with £2,941 in the corresponding period of 1890. The June receipts, estimated at £4,755, realised £4,803.

Swan United Company.—The Directors have resolved to recommend the shareholders to declare a dividend at the rate of 6 per cent. per annum for the six months ending 30th September last, and of 5 per cent. for the 12 months ending at the same date, making, together with the interim dividend declared in May last, a total dividend for the year of 11 per cent.

Change of Address.—Messrs. Barnett, Wynne, and Barnard, late of Newcastle-on-Tyne, inform us that on November 2nd they removed to new works at Walker Gate. All communications should be addressed to Barnett, Wynne, and Barnard, Volt Works, Walker, R.S.O., Northumberland. Telegrams should be addressed "Dynamo, Walker." The nearest railway station is Walker Gate, and the firm's telephone number is 6,510 on the National Telephone Company's Newcastle exchange.

PROVISIONAL PATENTS, 1891.

NOVEMBER 2.

18854. **Improvements in the construction of electrically-controlled arc lamps.** Frederick Thomas Schmidt, Sunbridge-chambers, Bradford, Yorkshire.

18855. **Improvements in dynamos and electric motors.** William Spiers Freeman, Invicta Works, Otford, Kent.

18857. **Improvements in meters for measuring electricity.** E. H. P. Humphreys, 8, Hyde Park-gate, London.

18890. **Improvements in rotary-phase current motors and dynamos.** Siemen Bros. and Company, Limited, 28, Southampton-buildings, London.

18897. **Improvements in methods of apparatus for regulating the supply of electricity used for lighting, motive power, or other purposes.** Reginald Wood, 35, Southampton-buildings, London.

18898 **Improved insulating and protecting devices for concentric electric mains.** William Frederick Taylor and George Joseph Philpott, 46, Lincoln's-inn-fields, London.

18899. **Improvements in electric meters.** William Frederick Taylor and George Joseph Philpott, 46, Lincoln's-inn-fields, London.

18902. **Improvements in the manufacture of tubular conduits for electric conductors.** George Frederick Redfern, 4, South-street, Finsbury, London. (Siegmund Bergmann.) (Complete specification.)

18905. **Improvements in electric railway signals, part of which are applicable to other signalling or alarm purposes.** José Ortega y Espinosa, 34, Southampton-buildings, London.

NOVEMBER 3.

18916. **Trollies for electric cars.** Robert Dunlop Nuttall, 6, Livery-street, Birmingham. (Complete specification.)

18928. **Improvements in the application of electricity to various useful purposes.** Edward Robert Dale, 8, Quality-court, London.

18931. **Improvements in apparatus and process for obtaining aluminium or other metals by means of electricity.** John Pullman and Howard Lane, 35, Southampton-buildings, London.

18938. **Process for producing filaments for incandescent lamps.** Rudolf Langhans, 61, Fore-street, London.

18976. **Improvements in arc electric lamps.** Thomas Parker and Edmund Scott Gustave Rees, 47, Lincoln's-inn-fields, London.

NOVEMBER 4.

19020. **Improvements in telephonic switching apparatus.** Alfred Rosling Bennett, 22, St. Albans-road, Harlesden, London.

19047. **Improvements in and apparatus for reducing or condensing induction currents.** Jules Cerpaux, 33, Chancery-lane, London.

19056. **Improvements in reflectors and appurtenances used in electric light photography.** Henry Vander Weyde, 53, Chancery-lane, London.

19071. **Improvements in the manufacture of wires for incandescent lamps, and in connecting the said wires to the filaments.** Rudolf Langhans, 47, Lincoln's-inn-fields, London.

NOVEMBER 5.

19134. **Improvements in or relating to electric meters.** Francis Teague, 433, Strand, London.

NOVEMBER 6.

19162. **Electric meter.** Arthur Moore Thompson and William Walter Gerald Webb, Holly Bank, Crewe, Chester.

19176. **Improvements in rotating magnetic fields, and in multiphase alternating currents.** Emil Alfred Wahlstrom, 4, Moorfields, London.

19190. **A multiple terminal for electrical distribution.** Ernest William Watling, 25, New-street, Dorset-square, London.

19211. **Improvements in or relating to electric meters.** Francis Teague and Ernest Francis Moy, 433, Strand, London.

19225. **A polarised electrical indicator.** Siemens Bros. and Company, Limited, and Alexander Selgius Schloemer, 28, Southampton-buildings, London.

19233. **Improvements in and relating to electric railways.** James Ferguson Munsie, 45, Southampton-buildings, London. (Complete specification.)

NOVEMBER 7.

19314. **Improvements in and relating to incandescent electric lamps.** Henry Harris Lake, 45, Southampton-buildings, London. (La Société dite Electriciteits Maatschappij System de Khotinsky, Germany.)

SPECIFICATIONS PUBLISHED.

1888.

12856. **Converting electric currents.** Zipernowski and Déri. (Second edition.) 8d.

1890.

6176. **Secondary batteries.** Barker. (Woodward). (Second edition.) 8d.

17711. **Distribution of electricity.** Edmunds. 11d.

18158. **Electric pressure indicator.** Gray. 8d.

18270. **Electrical conduits.** Munro. 8d.

19239. **Electric switches.** Barton. 8d.

19486. **Telephonic switching apparatus.** Bennett. 8d.

19650. **Distributing electricity.** Siemens Bros. and Co. (Siemens and Halske.) 8d.

1891.

9683 **Electric primary batteries.** Rawlins. 6d.

12046. **Electric motors.** Sahulka. 8d.

15597. **Galvanic battery.** Fisher. (Thompson). 6d.

15621. **Secondary or storage battery.** Currie. 8d.

15645. **Ceiling blocks and cut-outs for electric light circuits.** Greenfield and Kitner. 8d.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Brush Co.	—	3⅞
— Pref.	—	2⅞
India Rubber, Gutta Percha & Telegraph Co.	10	19½
House-to-House	5	5
Metropolitan Electric Supply	—	10⅞
London Electric Supply	5	2¼
Swan United	3½	5
St. James'	—	9⅛
National Telephone	5	4½
Electric Construction	10	6⅝
Westminster Electric	—	6¼
Liverpool Electric Supply	5	5¼
	3	2¾

NOTES.

Tiverton has decided to advertise for tenders from companies willing to take over their powers.

Nimes.—A central electric light station on the Ferranti system has just been opened at Nimes, France.

Train Lighting at the Cape.—The Cape Colony, it is stated, will shortly have all of its trains lighted by electricity.

Zincs.—The Spanish Postal and Telegraph Office at Madrid will require tenders for 40,000 zinc tubes on November 25.

Lenses.—Prof. Silvanus Thompson lectures on the "Measurement of Lenses" on Wednesday next at the Society of Arts.

Ludlow.—The question of the electric lighting of the borough came before the Ludlow Town Council last week, and was ultimately referred to the Watch Committee.

Palermo Exhibition.—The Italian National Exhibition at Palermo was opened amidst great enthusiasm by the King and Queen of Italy on November 15, escorted by an ironclad fleet.

Utilising Water Power in Sweden.—The waterfalls of Trollhättan and Motala, in Sweden, are to be utilised for supply of electric power in the towns of Gottemburg and Norrköping.

Marburg.—A mill owner at Marburg is intending to utilise a water power situated nearly 20 miles away, which will enable him to drive his mills and supply 600 h.p. besides in the town.

Calcutta.—The chairman of the Oriental Gas Company, at the annual meeting, mentioned that electric lighting had made little progress in Calcutta, and he thought they had nothing to fear at present.

African Telegraphs.—The extension of the British South Africa Company's telegraph line from Mafeking and Cape Town to Fort Victoria has now been completed, and an office has been opened at this place.

Crystal Palace Exhibition.—Mr. Musgrave Heaphy, C.E., has been appointed to supervise the various installations, as far as fire risk is concerned, during the forthcoming electrical exhibition at the Crystal Palace.

Cables Factory at Budapest.—Messrs. Jacottet and Co., of Simmering, Austria, are establishing a factory for cables and wires at Budapest, consequent on the advantages conceded to importers by the Hungarian Government.

Junior Engineering Society.—The president's address of this society will be given by Sir Edward J. Reed, on Nov. 27th. Amongst other papers to be read will be one on "Modern Applications of Electricity to Metallurgy," by Mr. Geo. C. V. Holmes, sec. I.N.A.

County Council Offices.—The Offices Committee of the London County Council, at the last meeting, recommended that 31, Spring-gardens, recently taken for office purposes, be provided with electric light at an estimated cost of £120, and that tenders be invited. This was agreed to.

Telephone Patents.—The Bell Company's shares have risen in New York with a decision on Tuesday of the Patent Office granting a new patent for Berliner instruments. Their rivals, however, naturally claim they will be able to make telephones in spite of this when the Bell patent expires.

Institution.—The next meeting of the Institution of Electrical Engineers will take place on November 26, when the discussion will be continued on the paper on "Description of the Standard Volt and Ampere Meter used at the Ferry Works, Thames Ditton," by Captain Sankey and Mr. F. V. Andersen.

Carbons.—Messrs. Nicholson, Bolton, and Tyler, of 100c, Queen Victoria-street, E.C., have, we hear, purchased the stock of the late Liepmann Carbon Company, Limited, of Millwall, and are placing them upon the market. We understand that the plant has been acquired by Messrs. R. Bolton and Co., of 110, Leadenhall-street, E.C.

Hong Kong.—The Hong Kong Electric Light Company are extending their supply of current. The manager, Mr. W. H. Wickham, reports considerable increase in private and public lighting, and mentions (an encouraging fact) that the Chinese seem to be taking favourably to the electric light, and several large native houses are being supplied.

Slate Quarrying. — The Thuringian slate pencil industry may derive great benefit from the Frankfort Exhibition. The slate is peculiarly hard, and borings were shown at the exhibition with electric drills which have attracted much attention in the slate district. With transmission of power the use of these drills becomes very feasible.

Electric Coal-Cutters. — The General Electric Traction Company have had for some time electric coal-cutters at work in northern collieries with great success. Repeat and modified orders of these have been received, and the introduction of electric cutters is regarded as solving the problem of gaining coal in many seams not otherwise worth working.

Arc Lamps.—Nearly 300 Brockie-Pell arc lamps have been sold during the last month. This figure, though nothing like so large as can be shown by makers in the States, is indicative of the increase of arc lighting, and now that schemes for public thoroughfares lighting are coming forward pretty rapidly, the figures may go up considerably higher during the next year.

Galatz.—With reference to the notices issued respecting tenders for the construction of tramways at Galatz, the Secretary of State for Foreign Affairs has now received a map of Galatz, showing the route of the proposed line of tramways. This map can be inspected on personal application at the Commercial Department of the Foreign Office, between the hours of 11 and 5.

Automatic Weighers.—It has been decided by Lords Justices Lindley, Bowen, and Fry, in the Court of Appeal, that the mere difference of having the "penny in the slot" to make electric contact, instead of imparting mechanical movement in the automatic weighing machine, is not sufficient to constitute a valid patent, and that the automatic weighing machine patent has been infringed.

Edison Electric Trains.—The *Engineering News*, in reference to the alleged statements as to driving trains by low-tension electricity, says that instead of three stations of 1,200 h.p., or a total of 36,000 h.p. mentioned by Edison, 400 times 500 h.p., or 200,000 h.p., would be required. A current representing 12,000 h.p. even would weld a pretty thick bar of iron, and "the rails might carry it, but how about the joints?"

Dundee Institute. — Some extremely interesting papers are arranged to be given before that enterprising association the Dundee Institute of Architecture, Science, and Art during the coming session. Among these are papers on December 10 by Mr. F. Grant Ogilvie, M.A., Principal of Heriot Watt College, Edinburgh, on "Electric Lighting of Houses"; and on January 24, 1892, by Mr. Ritchie, of London, on "Electric Light Supply."

Birstall.—An extensive installation of electric lighting has just been completed at the Birstall Print Works by the Manchester Edison-Swan Company. The current is generated by an Edison-Hopkinson dynamo, making 1,100 revolutions per minute, giving 180 amperes at 105 volts, and driven by a special horizontal condensing engine. Over 100 lamps are distributed over the colour-printing and engraving rooms and the mechanics' shop.

Thomson Meters.—An interesting indication of the progress of electrical matters is afforded by the figures given of the number of meters made by the Thomson Meter Company, of New York. On Nov. 2, 1887, it had manufactured 680 meters; on the same date 1888, 2,680; 1889, 4,860; 1890, 10,000; and to Nov. 2, 1891, 20,000 meters. The number of meters sold was 10,000, and a celebration was held at which the meter 20,000 was stamped.

Croydon.—The installation at Mr. Radford's house, Park-hill-road, Croydon, which we mentioned a year ago, is a neat example of private house lighting and has been running with satisfaction. There is a 1-h.p. nominal gas engine, by Campbell and Co., Halifax, a one-unit Elwell-Parker dynamo, 22 L11 E.P.S. storage cells, with Hartmann and Braun ammeters and voltmeters. The installation comprises 39 lights, 8 c.p. to 32 c.p. It was carried out by Messrs. Cathcart, Peto, and Radford, of Hatton-garden.

Electric Light on the Midland Railway.—The Midland Railway Company are taking steps to introduce electric lighting very largely for the working of the goods traffic. The difficulty of making up and distributing the goods trains at the great depôts at London, Manchester, Birmingham, Derby, Leeds, and other centres will be very considerably reduced if electricity be substituted for fitful gas lamps, and it is believed that installations will before long be introduced at the majority of the principal stations.

Induction in the City.—The engineer of the City of London Electric Lighting Company has applied for the London County Council's sanction to the use for three weeks, in the Queen Victoria-street subway, of two ordinary transformers, for the purpose of making certain experiments with reference to the possible effects of induction by the electric light mains about to be laid in the City. Sanction was given under proper conditions of control, and with the request that the results of the experiments be communicated to the Council.

Felsted.—The installation of the electric light at Felsted, which has just been completed, is of especial interest, as being the first public school in the country to be so lighted. The work has been carried out by Messrs. Drake and Gorham, who have been occupied at Felsted since July. The electricity is generated by a double set of engines and dynamos, and there is an accumulator battery of 53 cells. There are in all 385 incandescent lamps used to light the school buildings, including house rooms, dormitories, schoolroom, chapel, and gymnasium, all the lamps being with frosted bulbs.

Proposed Electric Tramway at Perth.—The Perth Police Commission at a special meeting held last week had under consideration a letter from Messrs. Robertson and Dempster, solicitors, on behalf of the promoters of a company applying for consent to lay a tramway from New Scone to the Glasgow-road, Perth. In the letter the streets through which it is proposed to lay the tramway were detailed, and it was stated that the mode of traction intended to be applied was electricity. After considerable discussion, the communication was remitted to the Commission in committee to consider and report to a meeting to be held that day month.

Length of Electric Waves.—M. Poincaré has announced to the French Académie des Sciences that M. Blondlot has measured by new method the length of waves of electric oscillations, and that he has found that this length is proportional to the square root of the capacity, and to that of the self-induction, as required by Sir Wm. Thomson's formula. The mean of his experiments has given for the speed of propagation of electric waves in a metallic wire a figure not greatly different to the speed of light—a difference less than can be accounted for by errors of observation. The result is confirmatory of Maxwell's theory that light is due to alternate currents of extremely short periodicity.

Leamington.—There seems to be not much field for the Aurora Electric Light Company in Leamington at present. The town clerk at the last meeting of the Town Council having read a letter from that company offering to supply the light, Mr. Councillor Crowther Davies remarked that the Council were rid of this electric light and intended to remain rid of it. "Give a dog a bad name"—the proverb is somewhat musty. O pioneers, what troubles have ye laid in store by the advocacy of the 16-c.p. "red-hot hairpin" for street lighting. Even Aurora, with all her charms, is now tabooed. However, it appears that only 35 shares out of 25,000 at £1 are paid up in "Auroras," so possibly not much harm is done.

Lineff Tramway.—We are sorry to hear that Mr. Lineff, the enterprising initiator of the magnetic continuous closed-conduit system, has been kept back in his work by illness. Mr. Lineff has lately been engaged in an interesting investigation with regard to the insulating properties of various kinds of combinations of asphalte under extreme climatic conditions of wet, cold, and heat. This is comparatively fresh ground for experiment, as until the present only the mechanical properties of asphalte have been studied. We are pleased to see that the Académie Parisienne des Inventeurs Industriels has conferred upon Mr. Lineff the diploma of honour and their great gold medal for his magnetic tramcar conductor.

Brooks Oil System.—We are interested to record the practical instances of use of Brooks's oil insulation. Three-quarters of a mile have been recently supplied to Ashton Court, Clifton, consisting of four strands of $^{10}/_{16}$ and four telephone wires in rough serving of jute pulled into iron tubes. The cables were for the transmission of electric light and power through the grounds to the mansion. This is one of several installations lately supplied, and in no case has any complaint been received. There is an important point to notice with reference to this system, and this is that the actual life of the pipe is largely increased by reason of the oil in the interior preventing oxidisation, which is not the case with any other drawing-in system.

City Lighting.—At the conclusion of the meeting of the Commissioners of Sewers at the Guildhall, on Tuesday, Colonel Haywood (the engineer) announced that he had just received a most important communication from the City of London Electric Lighting Company, entrusted with the carrying out of the street lighting in the City, praying for an extension of the time allotted them for fulfilling their contract. The letter in question was not read, as there were only a few members present, but the announcement gave rise to expressions of surprise. It was ultimately resolved to print and circulate the letter among the members of the Court at the earliest possible moment. The subject is likely to lead to a lively debate at the next meeting of the Court a fortnight hence.

Electric Cars in Paris.—The Compagnie des Tramways Nord, says the *Bulletin International*, will shortly inaugurate a new service of cars between the Opera and Saint-Denis. The cars will be run by electricity by means of Laurent-Cély accumulators supplied by the

Société par le Travail Electrique des Métaux at a price of 16c. per car kilometre—say, 2·15d. per car mile. This, we suppose, is for the supply and maintenance of batteries only. The route has several severe gradients, between the Rue Faubourg-Montmartre and the Rue Rochechouart the gradient is 5·5 per cent., or one in 18½. The line is six kilometres, nearly four miles, in length. The result of this further introduction of storage cars will be watched with great interest both in France and in this country.

Anti-Sulphuric Enamel.—Acid spray from a battery of accumulators is a great deteriorating agent where metal fittings and brass or copper conductors are about. Messrs. Griffiths Bros. and Co., of Macks-road, Bermondsey, apparently "at request of Messrs. Crompton and Co.," set to work and invented an anti-sulphuric acid enamel, which is now largely used in many electrical works. For coating woodwork, iron, and copper in the neighbourhood of batteries, it seems to have proved itself thoroughly successful, and the long list of names of electrical firms using this enamel shows its popularity and usefulness. Even with strong sulphuric acid it will resist for weeks. At Kensington Court they seem to find it a perfect protection against acid spray. It is applied exactly like varnish, in black or other colours.

South London Railway.—Two new Siemens locomotives will shortly be added to the present set of electric locomotives on the South London Railway, and others will be added as the traffic necessitates. One of these has already been tested and the other is ready for delivery. Various alterations in detail have been made in the arrangements, making the electric locomotive still more like a steam locomotive, and embodying certain simplifications of management and driving. The foundations of the new generating engine are now fixed and the engine is expected to be erected shortly. The number of new electric railways proposed to be built, as mentioned elsewhere, seems to be conclusive proof of the favour with which the underground electric railway traction is becoming regarded in engineering and financial circles.

Heyl Accumulator.—In the accumulator introduced by M. G. E. Heyl, the electrodes are composed of combinations of plumbic, chromic, or tungstic acids with calcium, barium, or strontium. To increase the coefficient of output and capacity, the inventor uses more particularly compounds of calcium and lead for the reason that these are easily oxidisable. The combination $CaPbO_4$ corresponding to 68 per cent. of peroxide of lead, contains 4·56 per cent. of active oxygen. The other alkaline earths, or of baryta, or strontium, furnish analogous compounds applicable to the purpose. Besides the advantage resulting from the chemical nature, the compound $CaPbO_4$ would offer a further valuable property in its porosity; it might replace the diaphragm employed to separate the elements of cells. The analogous compounds of chromium and tungsten can be employed in the same manner.

St. Pancras Mains.—Prof. Robinson, engineer to the Vestry of St. Pancras, has written to the London County Council with reference to the precautions which the Vestry proposes to take to prevent risk of accident from the electric lighting cables which are being laid down in the parish. It is suggested that where the high-tension cables pass through the boxes they shall be guarded by a semicircular stoneware cover, except in those few cases where it may be found difficult to fit the cover, and in these exceptional instances it is proposed that substantial wooden casing shall be used. By adopting these means it is expected that contact between the cables and the iron manhole covers of the street boxes will be rendered absolutely impossible. These suggestions are approved by Major Cardew, who has looked into the subject on behalf of the Board of Trade, and have also received the approval of the London County Council.

Long-Distance Telephones in Australia.—The *Melbourne Argus*, October 5, says: "An interesting telephoning experiment was made in Melbourne during the week, when the Postmasters-General of Victoria and South Australia, with their principal executive officers, succeeded in establishing conversation between Melbourne and Adelaide, a distance of 500 miles. The Governments of the two colonies have just completed the suspension of a copper wire (known technically as a 'number twelve,' and rather more than an eighth of an inch in thickness), which is to be used for the new quadruplex telegraphic instrument; and the idea suggested itself of seeing what could be done with the telephone over the wire. For over an hour an animated conversation was carried on, and the chimes of the Adelaide Post Office clock were distinctly heard in Melbourne, and *vice versâ*. The instruments used at Melbourne were the Hunning, Berthon, Berliner, and the Blake, and the two former were found most effective."

Leeds Electric Tramway.—At a meeting of the Highways Committee of the Leeds Corporation on Wednesday, Alderman Firth presiding, communications were read from the Board of Trade respecting the recent inspection by Major-General Hutchinson and Major Cardew of the Roundhay-road, Beckett-street, and Harehills-road tramway. Accompanying these were the necessary Government certificates for the working of these routes. As bearing on the question, it may be mentioned that at the same meeting a resolution was passed requesting the Parliamentary Committee to insert a clause in the new Consolidation Bill giving the Corporation power to either lease the tramways of the borough to the tramways company, or to acquire them and work them themselves. It is hopeful to find the interest already being taken by other corporations in this enterprise is beginning to show itself. A deputation of the Wigan Corporation, headed by Mr. Gee, chairman of the syndicate which has bought the tramways in Wigan, went over the line last Saturday with satisfaction.

Telegraphing Races.—An interesting fight went on a few weeks ago over the racing reports of the Jockey Club, New York. The proprietors of the club refused to give information to the Western Telegraph Company unless for heavy payment, which they would not pay. All sorts of devices were tried to circumvent the club—pigeons, towers, and smuggled wires. Pinkerton's detectives stopped this, but at last for four days reports were published, and the method at last discovered revealed a most ingenious system. The coachman of a private carriage had a hat fitted with a tiny incandescent lamp, the flashes from which were read by means of a telescope on the top of a hotel at a distance, a man being stationed with red, black, and blue flags to mean "out of focus," "repeat," "stop," and so forth. No signals except those in the hat were made at the carriage, and the flashes were invisible except in the line to the telescope. The Western Company were satisfied the scheme would have continued to work successfully if someone had not let the cat out of the bag.

Fire at Laing, Wharton, and Down's.—The premises in the occupation of Messrs. Laing, Wharton, and Down, at the rear of 82A, New Bond street, were destroyed by fire on Tuesday, the damage being estimated at upwards of £8,000. The building consists of four floors, and it was in the first of these that the fire broke out, flames being observed about half-past nine by a servant in Haunch of Venison-yard. The conflagration spread with remarkable quickness, and although the alarm was promptly given by the police and as promptly responded to, the building was well alight some minutes before the arrival of the firemen. Thanks to a good supply of water from the Grand Junction Water Works, the danger, which at one time seemed imminent, of the fire spreading to adjoining buildings was averted. In less than an hour and a half, however, the premises of Messrs. Laing, Wharton, and Down were gutted from top to bottom, and their valuable property destroyed. They are, however, making arrangements which will enable them to execute orders promptly as ever, if friends will give them a few days' grace.

Proposed New Electric Railways.—The Hampstead, St. Pancras, and Charing Cross Railway has notified its intention of seeking powers next session to construct an underground railway from Hampstead to Charing Cross, the line of route following as nearly as possible the main thoroughfares between Charing Cross and the north-western suburb — viz., Tottenham Court-road, Hampstead-road, Camden Town, and Haverstock-hill. The necessary plans and specifications will be deposited with the officials of the Houses of Parliament, the London County Council, and the various local authorities concerned by the proposal this month. The City Commission of Sewers, on Monday, gave instructions for the posting of notices in the City with respect to the proposed railway from Waterloo to the Mansion House, the extension of the Central London Railway from the Poultry to Liverpool-street, the construction of a line from Finsbury Park to Moorgate-street, and the Islington extension of the City and South London Railway. In all of these there will be two separate tunnels, and electricity will be used as motive power.

Glasgow Tramways.—The all-important question at the present moment in Glasgow of the transfer of the tramways to the Glasgow Corporation, was very fully discussed at the meeting of November 12th, and the decision was come to by the overwhelming majority of 49 against six that the tramways should be so transferred. The committee are instructed to consider and report upon the scheme for running the tramway by means of mechanical motors, and to make arrangements for testing the same in a practical manner. This decision is very satisfactory from several points of view. It is no secret that the present tramway company works its men far too long hours, and the service might be greatly improved while the present dividend was at the rate of 9½ per cent. The Glasgow Corporation have recently taken much pains to obtain the best information upon electrical traction, and it is greatly to be hoped that the experiments to be undertaken will result in the establishment of an electric service, which, if carried out, will be one of the most extensive yet proposed in Great Britain.

St. James's Park.—An application has been received from the Electricity Supply Corporation by the London County Council of intention to lay down and construct street boxes along sides of and across Spring-gardens and the Mall, St. James's Park. With the Mall the Council have nothing to do, that place being under the jurisdiction of Her Majesty's Office of Works; but as regards the other part the proposed works are of the same nature as previously carried out by this company, and the committee recommend that the sanction of the Council be given to the works referred to, so far as such notice relates to places within the jurisdiction of the Council, upon condition that the company give two days' notice to the Council's chief engineer before commencing the work; that the mains shall be laid in the footways wherever it is found practicable to do so; that the concrete floor of the road boxes shall be made 9in. thick; that the York stone on the top shall be 4in. thick; that the brickwork of the boxes shall be 9in. thick; and that the longitudinal girders on all the boxes shall be laid in 3in. stone templates the full thickness of the brickwork.

Electric Mining.—Electricity *versus* compressed air was a topic at the general meeting of the South Wales Institute of Engineers on Tuesday. Mr. Albion T. Snell presented a paper on "Electric Work in Mines," and at the luncheon he said that the main object he had in view was the reduction of cost of getting and raising coal. Hitherto electricity had only been used on any scale for pumping and hauling, but in the near future they hoped to get the coal by the same means. In Yorkshire they were experimentally working a machine constructed to work at the height of 24in. by 39in. wide at 20 yards an hour, a speed already realised, so that the cost would be materially reduced. In Welsh coal the seams were thicker, but where seams were thin the mechanical coal-cutter was a great advantage. Further, such a machine would not join the strike, and might be used as a reserve, while it would certainly in many cases get the coal cheaper than by manual labour. With reference to efficiency, Mr. Snell stated they had succeeded in demonstrating that electricity would pump water or haul coal with an efficiency which was something like double that obtained by compressed air. Mr. Archibald Hood immediately offered to take several electric plants if Mr. Snell would demonstrate this fact to him. We hope the contract will come off.

Liverpool Installations.—We give the following additional particulars of the important installation that has just been completed at Messrs. Henechsberg and Ellis's new premises, Liverpool, to which we alluded last week. The installation was carried out to the specification of Mr. Thomas L. Miller, A.M.I.C.E., M.I.M.E., 7, Tower-buildings, Liverpool, and under his superintendence. It consists of a Crossley gas engine fitted with their patent self-starter, and capable of developing 26 h.p. on the brake. This drives a Tyne dynamo of the four-pole type, the current from which is led to the main switchboard, supplied by Messrs. Munroe's Manufacturing Company, of Glasgow, and thence passes through six double-pole switches with double-pole cut-outs to the various circuits throughout the building. The installation consists, in addition to 140 glow lamps, of two 10-ampere arc lamps running in series, and two 10-ampere lamps, running in parallel and in series with the 20-ampere mast-head light. Two 5-ampere arcs are also used for the doorway, and four 5-ampere arcs running in parallel and in series with a 20-ampere arc lamp fitted on a 16in. projector, fixed on the tower, sending its rays through four windows over the city. The lamps are run from a 110-volt circuit. As mentioned last week, Messrs. A. Hall and Co. were the contractors for the work.

St. Pancras Station.—The St. Pancras central station started supplying a few lamps last week. This station promises to be a great success, if the demand, which we understand has arisen, is found to continue and increase. One firm alone has wired houses for between 2,000 and 3,000 lamps in this district. It is true this is a local firm, but there must be several others who have done almost as much, and at this rate the 20,000-lamp capacity will soon be exhausted. Some of the arc lamps on standards, tastefully designed by Messrs. Johnson and Phillips, are already erected, apparently to the satisfaction of everyone. Messrs. Baker's large shop at the corner of Tottenham Court-road is fitted with 48 arc lamps (installed by Messrs. Sharp and Kent) waiting for the current. This corner will be a perfect blaze of light when the lamps are lighted. The shopkeepers of Tottenham Court-road will have both public and private lighting, and this wide but somewhat dingy thoroughfare will soon be one of the best lighted in London. This cannot but have an effect on the shopkeepers of Hampstead-road and other places, and the current of the St. Pancras Vestry will be sought with entreaties. The low price per unit, 6d. if we remember, has caused misgivings to arise in some electrical engineers' minds, but a full load will we hope yield a fair profit, and cause the example of St. Pancras to be widely imitated.

Overhead Wire Electric Cars.—The General Electric Traction Company, besides attention to accumulator traction, which it is to be hoped will shortly result in the establishment of storage car services in the North, have also given their endeavours towards overhead conductor systems, and have issued a small pamphlet describing the advantages of these electric cars. The pamphlet is not a technical one, but is intended to interest tramway managers and municipal authorities, and bring the advantages of electric traction in one form or another before the public. It is illustrated with some tasty illustrations of electric cars passing by suburban residences, with handsome poles down the road. They think the cost should certainly be less than 3d. to 3½d. a car mile for 70 miles each a day. The car on the overhead system would be 2½ tons lighter than that with storage cells, and in cases where the line might have wires without difficulty, such as in suburban districts, it would have the advantage of less wear and tear on the rails, besides cheapness of maintenance. The company, in the concluding paragraph of the pamphlet, seem to have an envious eye on the Thames embankment as a fine ground for their talents, and indeed it were well to see the "fine canopied cars" of the Traction Company on that famous highway, and in many another highway that is waiting. Between storage and overhead systems the General Electric Traction Company ought to be able to show results *pour encourager les autres.* We hear that another tramway company is face to face with the necessity of spending large sums either on removal of their unsatisfactory steam car engines, or on an electrical system. We hope it may prove they will not hesitate, but hasten to find their salvation overhead.

Visit to Royal Institution.—A memorable visit was paid on Saturday afternoon, by the members of the Junior Engineering Society, by kind permission of Lord Rayleigh and Prof. Dewar, to the Royal Institution laboratories in Albemarle-street. Some 60 or 70 visitors arrived and collected in the library. A move was first made to the lecture theatre, where the famous lectures of Davy and Faraday were given. The next visit was to the chemical laboratory. Here were several very powerful pumps and other apparatus for the liquefaction of gas. Here also is a chemical balance designed by Faraday shortly before his death, the accuracy of which is marvellous. Adjoining this room is a little sanctum which was largely used by Faraday, and his chair is shown. This is one of the few parts of the old building left. A queer, dark little hole it is, too—sans air, sans light, sans everything. After doing justice to this hallowed spot the visitors adjourned to the more prosaic engine-room and examined the gas engine and dynamo. The room was, however, rather small, and they soon made their way to the electrical laboratory and museum. This was, perhaps, the most interesting of all. In the cases along the side were seen Sir Humphry Davy's original safety lamp and the various forms of gauze which he tried. In the next case were Faraday's famous induction rings and the various pieces of apparatus which he constructed for showing the magnetism of light. The induction ring, small precursor of the modern giant dynamo, was of great interest, and the precious relic was handed reverently round for examination. In this room also were some old alchemist's apparatus and a large machine. In the physical laboratory, which was next visited, was a cooling apparatus for throwing out a jet of liquid carbon dioxide. In the next room were some of Tyndall's specimens of rock salt, and also some of the designators and sound apparatus of Prof. Helmholtz. A visit was also paid to the leads, where a large number of accumulators are kept in long troughs. Finally, a return was made to the lecture theatre, where the magnificent electric lantern was examined, after which the visitors thanked their courteous guides and left, having spent a most enjoyable afternoon in this classical spot.

French Storage Cells.—The *Times* has an article on "Electrical Storage," on November 17, which is calculated to carry dismay and envy into the ranks of accumulator monopolists, and to make traction companies wonder why they bound themselves to any make of cells when the possibility is now demonstrated of the procuring of cells, weight for weight, of "four times the capacity of any known accumulator." This is the storage battery of the Société Anonyme pour le Travail Electrique des Métaux, the output of whose works at Saint-Ouen, Paris, is at the rate of five tons a day, with a capacity for 10 tons. Cells with a total storage capacity for 70,000 lamps are now in use at Paris. The working capacity and durability of these accumulators are sought to be increased without increase of weight or cost. For this purpose the plates are made of grid pattern, with square holes filled in with reduced lead of great porosity. Chloride of lead and chloride of zinc are melted together and the fused salts moulded in cakes of 2in. square of desired thickness. The cakes are formed with cross grooves on both sides and a small hole through the centre. When cool they are removed from the mould, laid in batches between perforated iron plates and placed in a bath of hydrochloric acid for 15 days. The chloride of zinc is thus dissolved out. The cakes are afterwards dried, placed in moulds, and molten lead poured in, forming a framing, the lead also running into the grooves on the faces of the blocks and into the small hole—a self-supporting plate of good conductivity being thus produced. The plates are trimmed up and placed with zinc plates between them in a solution of chloride of zinc, which reduces the chloride of lead squares to pure porous metallic lead, the last traces of chloride of zinc being removed by a bath of dilute hydrochloric acid. They are afterwards washed several times in alternate pure and acidulated water. The process of reduction and cleansing are now complete, an examination of the interior of the squares showing the pores of regular structure at right angles to the surface of the plate. The plates are then formed in the usual way by passing currents of electricity, the efficiency of the resultant cells being remarkably high. The ordinary plates made by the Société have a capacity of 10 ampere-hours per kilo (4·5 per pound). Cells of special type for traction purposes possess the high rate of 19 ampere-hours per kilo (eight per pound). A remarkable feature is the high rates of charge and discharge. An installation at the Hotel Continental having 55 half-ton cells, has an ordinary output of 600 amperes, and on an emergency of 1,200 amperes, at 110 volts, without noticeable fall in voltage, and without detriment to the plates. The largest installation where they are used is that of M. Popp, where 25,000 16-c.p. lamps are supplied. There are no less than 16 sub-stations, all charged from one central generating station. The engines cease running at 4 p.m., the batteries carrying the entire load till next morning. These accumulators have been adopted by the French Government after severe tests, and, it would seem, constitute a most important advance in this department of electrical practice.

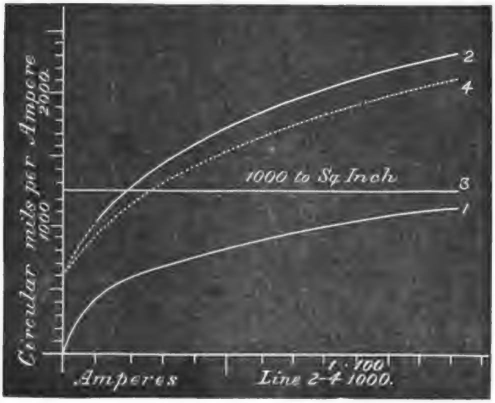
SAFE CURRENT LIMIT OF CONDUCTORS.

BY JOHN T. SPRAGUE.

This subject has been very thoroughly examined both by mathematicians and practical engineers, and much information has been published, while much is no doubt held as a useful trading property. My present purpose is not to add an actual contribution of my own to the stock of knowledge, but to put the work of others into a form which appears to me to convey the facts in the simplest possible form, alike to the eye and to the mind.

The problem to be dealt with is the amount of heat generated by the current, and the rate of its dissipation by the processes of transmission (or conduction), radiation and convection. We have to find out the conditions under which these two just balance, so as to produce a defined rise of temperature which shall do no damage. It is clear that no formula whatever can do this for all cases, unless we can introduce some variable element, a constant for each case. But we can discover a law which the practical man can modify as his experience teaches him.

Two very natural ideas were at first accepted: 1. That the conductor should increase in the ratio of the current. 2. That bare wires would cool more rapidly than those cased in badly-conducting materials. But both these ideas soon proved erroneous. The first did not allow for the fact that as the conductor and its conductance increased as the square of the diameter, while its surface only increased as the diameter simply, the cooling powers rapidly diminish in ratio to the heating actions. The second left out of sight the fact that the non-conducting covering rapidly enlarges in surface, and so increases the power of heat diffusion. It is now recognised that encased wires may carry a much larger current at the same temperature as bare ones, because the covering disposes of some 25 per cent. more heat than the bare wire can. On the other hand, the bare wire may often permit a very much higher temperature than the covered one.



The formula C^2 varies as d^3 or $C = d^{\frac{3}{2}}$, which was first devised, I think, by Prof. Forbes, who also showed that it was not strictly correct; it amounts to saying that the diameter of the wire must increase as the current, and not the square root of the diameter, which is the law of conductance. Prof. Forbes applied various constants to this law relating to the functions of heat, and worked out many valuable formulæ and tables. Several others have taken up the subject and done good work, but the most complete study of the whole matter that I am acquainted with is that of Mr. A. E. Kennelly in a paper read to the Edison Convention in August, 1889. He experimentally tested the rate of heating in various conditions in such a manner as to test the correctness of the theoretical data adopted by Prof. Forbes, and it must be admitted that these data, while subject to much modification, proved very fairly trustworthy. Mr. Kennelly gave a number of diagrams and curves showing the actions, which are worthy of close study by those who desire to understand the whole subject, but he did not give the one curve which makes the law clear at once, and it is to supply this that I am now writing.

The law of conductance is that every part of a conductor carries equal current, except in the variable periods with intermittent currents—that is to say, that if we define our unit wire as having the area of one circular mil the conductance will vary as the number of these unit wires, which is given for round wires by d^2. Then what we require to know is, what is the number of such unit wires which will carry one ampere of current under given conditions. The safe limit was set at various figures—2,000, 1,000 amperes per square inch. But 1,000 amperes per square inch means 1,273 circular mils per ampere, while we know that a wire of 200 circular mils will carry an ampere current with very little heating. In the accompanying diagram I have given the curve derived from Mr. Kennelly's experiments, and this curve shows how the circular millage must be increased as the cooling powers reduce by enlarging the wires. The horizontal scale gives the currents as ordinates of the curve, and the vertical scale gives the millage as the abscissæ. For any current the square root of these two multiplied together gives the diameter required.

For currents up to 120 amperes, curve 1 applies. For currents up to 1,200, curve 2 is on one-tenth the scale as to amperes.

They show the conductor needed if the limiting rise of temperature is to be 10deg. C. in the case of copper wires of 98 per cent. conductivity enclosed in casings. This is the average temperature which ensures compliance with the regulation that conductors shall not rise more than 150deg. F. with double the normal current.

Line 3 marks 1,000 amperes per square inch, and shows that for currents under 300 amperes it is wasteful of copper, and for higher currents it may become unsafe.

The dotted line 4 is calculated from the figures of Prof. Forbes for a bare wire suspended in air and permitting a rise of 25deg. C. It shows in a very striking manner how fairly the theoretical data and the law of $C^2 \propto d^3$ apply to the facts. The curves all demonstrate also the advantage of using small conductors, and especially strips rather than wires, under conditions which permit diffusion of heat, rather than single large masses of metal. Thus, to carry 1,000 amperes, 1,000 × 2,160 = 2,160,000 circular mils; but four wires each carrying 250 amperes means 4 × 250 × 1,370 = 1,368,500 circular mils, or little more than half the weight of copper.

From the curves shown in the diagram it is easy to trace out such others as would meet any requirements, or to extend the curve 2 to any desired amperages.

INSTITUTION OF ELECTRICAL ENGINEERS.

At a meeting of the Institution on Thursday, November 12, there was an exceedingly interesting preliminary to the reading of the paper, part of which we gave last week, and which we conclude elsewhere. As we say, the usual preliminary business was agreeably diversified. The president announced that the council had elected Mr. Jacob Brett an honorary member of the Institution, in recognition of his valuable services in connection with the introduction of submarine telegraphy. He also announced two very interesting donations—viz., an excellent portrait in oils of Mr. Jacob Brett, painted and presented by Miss Alice Bolton, of 49, Blomfield-road, Maida-vale; and seven volumes of manuscript letters and manuscripts formerly belonging to the late Sir William Fothergill Cooke, relating to the introduction into England of the electric telegraph by himself and his partner, the late Sir Charles Wheatstone, presented by Mr. Latimer Clark, past-president.

Mr. **CLARK**, in acknowledging the vote of thanks to himself, and in seconding a similar vote to Miss Bolton, made some very interesting remarks, as follows: I have great pleasure in seconding this motion, but before referring further to the subject I feel bound to return my thanks for the kind way in which you have accepted from me the letters, documents, and papers of the late Sir Wm. Fothergill Cooke, which I have had the honour to present to the Institution. Anyone who looks into these letters will find their perusal very interesting, and I can vouch for the fact that they are historically extremely valuable, because they relate to the history of the introduction of the electric telegraph into this country at a date so early that it is not possible that anything earlier can be discovered. We owe it to the business aptitude and energy of Sir William Cooke, assisted by his partner, Wheatstone, that the electric telegraph was introduced on the railways of this country at a very early date, and before it was taken up by other countries, so that Great Britain will for all time to come claim the honour of having first introduced the electric telegraph into practical use, as it can also claim the first invention of electric telegraphy through the celebrated letter of "C. M." in the *Scot's Magazine* of 1753.

Although I knew Sir William Cooke extremely well and for a great number of years, it was a long time before I could induce him to entrust to me the valuable papers he had in his possession. For many years I used on every opportunity to urge on him that they should be deposited in some public institution, and it was only some 10 years ago that he at last consented to place them in my hands, as part of a large collection of works which I had been accumulating, and which I assured him would sooner or later find their way to some public library. When I did obtain possession of them a great many were found missing, in spite of every search he could make. They now comprise seven volumes, containing all kinds of documents of a legal or business nature and a great many private letters. Perhaps the most interesting part of the collection is a series of private letters to his mother and his brother detailing the inception and early development of his ideas. He was most affectionately attached to his mother, and his letters to her abound in expressions of filial love which are quite touching. They were written in the old days of high postage rates, and as was customary in those days, they were crossed and recrossed in such a way that it is difficult to read them, and would be still more difficult to find space for an additional 20 words in any of them.

Our honorary solicitor, Mr. George Bristowe, has very considerately made a copy of all those portions which relate to the electric telegraph, and this will be found in a separate volume. He has done this not only with a view to their more easy perusal, but he was impressed with their historic value, and he kindly undertook this duty with a view to their safe preservation from fire or other accident, deeming it unsafe that only one copy should be in existence. I will venture to read an extract from the first letter to his mother, dated April 5, 1836, because it is always interesting to trace the first movement in a path from which such mighty results are afterwards destined to emanate:

"Heidelberg, April 5, 1836.

"My Dearest Mother,—You must know that for some weeks past I have been deeply engaged in the construction of an instrument which I believe may prove of sufficient importance, should I succeed in bringing it to practical perfection, to merit a visit to London. Determined to satisfy myself on the working of the machinery before I went any further, I prepared to make a model, and being unable to obtain the requisites at Heidelberg, I sought them at Frankfort. Whilst completing the model of my original plan, others on entirely fresh systems suggested themselves, and I have at length succeeded in combining the utile of each, but the mechanism requires a more delicate hand than mine to execute, or, rather, instruments which I do not possess. These I can readily have made for me in London, and by the aid of a lathe I shall be able to adapt the several parts, which I shall have made by different mechanicians for secrecy sake. Should I succeed, it may be the means of putting some hundred pounds in my pocket. As it is a subject on which I was profoundly ignorant till my attention was casually attracted to it the other day, I do not know what others may have done in the same way; this can best be learned in London. You see, I am very mysterious at present, and think it very prudent to continue so. Nevertheless to you, dearest mother, if it were your wish, my plan and instrument should be explained now, though I think without better drawings than I could make you would scarcely comprehend me. As I do not wish my motives for revisiting London to be generally known, you had better, in mentioning it to my friends at Berne, state that private business requires my presence, and allow them to ascribe to modelling or what they please the sudden change of my plans."

This is a sample of the correspondence which goes on for a great many years. But besides these the collection comprises autograph letters from several very eminent persons, and many papers connected with the celebrated arbitration between himself and Sir Charles Wheatstone, and with the introduction of the telegraph and the formation of the Electric Telegraph Company, which was the first public company established for the purpose of telegraphic communication, and which opened its doors to the public on the 1st January, 1848, at which time about 1,500 miles of telegraph were in existence.

Life is proverbially uncertain, and I have, therefore, had very great pleasure in confiding these papers and documents to the care of the Institution of Electrical Engineers, and I thank you sincerely for the kind way in which you have accepted them.

I have now the pleasure of seconding the vote of thanks which has been proposed to Miss Alice Bolton, of 49, Blomfield-road, Maida-vale, for her presentation to this Institution of the very artistic and excellent portrait of Mr. Jacob Brett, which we see before us. Its artistic merits are very obvious to us all, and I can testify to its being an excellent likeness, as I have had the pleasure and privilege of knowing Mr. Brett for a great many years. It represents him not so much as he is to-day, but rather as he was some four or five years since, when the portrait was originally painted. Mr. Jacob Brett is now 83 years of age, and I grieve to say he lies on a sick bed through an accident which occurred to him some time ago in getting out of a vehicle; one of his legs was injured, and as the wound has reached the surface of the bone it is extremely difficult to heal. It is a great pleasure to me to know that Mr. Jacob Brett has been elected one of the very few honorary members of this Institution, for I feel that in conferring honour on Mr. Brett we have, perhaps unwittingly, conferred an honour upon ourselves.

I do not think it probable that many of those whom I see present with us this evening can be fully aware of the very important part which Mr. Jacob Brett and his brother, Mr. John Watkins Brett, have played in connection with the history of the introduction of the electric telegraph, and especially the submarine electric telegraph, into the country and into the world. That connection dates back to a past generation, and is much deeper and more important than the world generally is aware of. His brother (Mr. J. W. Brett) and Mr. Brett were close friends and partners, and worked together in all their undertakings. His brother had a considerable fortune, which he was always ready to lavish on the advancement of submarine telegraphy. They commenced their public labours in 1845, and it is through their energy and devotion to the subject that we as Englishmen can claim for ourselves the distinction of having been the pioneers in the introduction of submarine telegraphy, as we can equally claim to have been the first nation to invent the electric telegraph, and the first nation to introduce it into practical working. In order to be able to appreciate the early date at which they began their labours, I would remind you that in 1837 Cooke and Wheatstone exhibited the private working of their telegraph from Euston to Camden Town, and the public then for the first time became aware of the possibility of the introduction of the electric telegraph as a factor in daily life. During the ensuing years Sir W. Cooke, by his great business energy, succeeded in establishing telegraphic lines on many of our railways; as for example, the Norwich and Yarmouth line, the Dalkey atmospheric line, the Northampton and Peterborough, the South-Eastern, the Great Western, and others. But on January 1, 1845, an event occurred which startled the public mind contributed most powerfully to the advancement of the electric telegraph. On this date occurred the notorious case of a murder of a woman at Slough, by the Quaker, John Tawell, and his arrest was effected by the telegraph. After he had left by train for Paddington, a description of the murderer was forwarded by telegraph, and on his arrival he was seen to enter an omnibus. A detective mounted on the roof, and after watching him through several streets in the City, followed him into a small eating-house in an obscure and narrow alley, and seated himself opposite to him. Having satisfied himself by observation that he was in the presence of the right man, he suddenly accosted him with the question, "Haven't you just come from Slough?" Tawell's astonishment and his haggard looks at once betrayed his guilt, and he was eventually condemned and hanged for the crime. This episode occurred in 1845, and made a great impression on the public mind, and I have no doubt had its influence on the two brothers Brett, for on the 16th of June of that year they registered the General Oceanic Telegraph Company. I shall have to refer later on to this company, but for the moment only call attention to its date and to the fact that the Electric Telegraph Company, the well-known pioneer telegraph company of Great Britain, was not registered until the 2nd of September in the same year.

On the 23rd July, 1845, the two brothers laid before Sir Robert Peel and the Government their plans for uniting Dublin Castle with Downing-street, and also for a general system of oceanic and subterranean electric telegraphs, to include the United Kingdom and the colonies, together with the establishment of a system of postal telegraphs throughout Great Britain. That letter was printed in type by an electrical type machine patented by the Bretts, which was exhibited at 29, Parliament-street, and I well remember seeing it at that time. Copies of the letter were extensively distributed, and I believe that the instruments themselves are stil in the possession of Mr. Jacob Brett. In the following year, 1846, they applied to the French Government for a concession for a cable to be laid at their own expense from England to France, and in 1847 this concession was granted to Messrs. Brett by his Majesty Louis Philippe, and in 1849 was further confirmed by Louis Napoleon, the President of the French Republic. They also applied in this year for a Belgian concession, which was granted to them in 1852.

In 1850 they laid down their first submarine line, the well-known single wire of guttapercha, which was successfully completed on the 28th of August, just in time to save their concession. That wire, as we well know, was so slight that it failed almost immediately, but it was followed in 1851 by a permanent cable of a very different character, which, subject to repairs, was working in portions for 20 years or more; in fact, no record exists of the date of renewal of the last remaining portions of it. This cable contained four conductors, and was armoured with stout iron wires in the usual manner; in fact, it formed the type for all future submarine cables. The success of the line enabled them to form, in 1852, the Submarine Telegraph Company, Mr. J. W. Brett himself being one of the directors, which proved one of the most prosperous and successful of cable companies, and has only recently passed into the hands of the British Government.

In 1853 they laid the first Belgian line and formed the Mediterranean Electric Telegraph Company, followed by cables to Corsica, Sardinia, Algiers, and many other places, while they were incessantly active in pushing forward their great scheme for a line of cables across the Mediterranean to Egypt, the Red Sea, India, and Australia. Mr. J. W. Brett was also a director of the British and Irish Magnetic Telegraph Company, which, in combination with others, formed so powerful a rival to the old Electric Telegraph Company.

Now, it must ever be a source of suprise that with such records as these the name of Brett should have been omitted or forgotten in 1866, when the somewhat lavish distribution of honours and titles was made in consideration of the splendid success of the Atlantic undertaking, and that surprise will not be diminished when I proceed to show you that Mr. J. W. Brett was himself the originator and one of the earliest and strongest supporters of that project.

I have said that on the 16th June, 1845, Mr. Jacob Brett had registered at the Joint-Stock Company's office the General Oceanic Telegraph Company, the first telegraphic undertaking ever registered. I have seen the original certificate and receipt. But what is more curious is that even at that early date, the application goes on to say: "Object specified to form a connecting mode of communication by telegraphic means from the British Islands and across the Atlantic Ocean to Nova Scotia and the Canadas, the Colonies, and Continental Kingdoms." So that we are met by the extraordinary fact that the first telegraphic company ever registered in this country was formed, not with the object of erecting telegraphs on land, but for the purpose of laying a submarine cable across the Atlantic Ocean, and this at a period when the world at large had not even heard of submarine telegraphy. Later on, in 1855, we find Mr. J. W. Brett associated with Peter Cooper, Cyrus Field, Dudley Field, Prof. Morse, and other prominent names, in founding the New York, Newfoundland, and London Telegraph Company, and I have seen the receipt for the £3,000 which he contributed in 1856 as his share to the common fund. In October, 1856, we find the "Memorandum of Association of the Atlantic Telegraph Company" with a capital of £300,000, in 300 shares of £1,000 each; and again we find Mr. J. W. Brett's name at the head of the list with a subscription of £25,000, followed by the subscription of a like sum by Cyrus W. Field; and subsequently we find his name at the head of the list of directors of the Atlantic Telegraph Company, which was at first unsuccessful.

It is most difficult to understand how such splendid services in the cause of electric telegraphy could have gone unrequited and unnoticed. One can only conjecture that he must have impoverished his fortune by his too great liberality in his efforts to advance the cause of submarine telegraphy, so that when the final victory was won, and the hour of triumph and reward came, he was unable to take his place in front, and was left aside unnoticed and forgotten.

I feel very much gratified that this Institute should possess a portrait of the only survivor of the two brothers whose names will go down to posterity as those of the fathers of submarine telegraphy, and I have therefore the greatest pleasure in seconding the vote of thanks to Miss Alice Bolton. I can only regret that the very artistic portrait which she has presented to us this day cannot be seen by a wider circle, for it could not fail to add largely to her professional reputation. We also owe a debt of gratitude to her and her mother for the affectionate care with which they have assisted Mr. Brett during many long years of public neglect. As for Mr. Brett himself, I regret to say that he is in extremely straightened circumstances. He has for many years subsisted entirely on a pension of £100 a year which was granted to him from the Civil Service Fund, and he has no other means of subsistence. It will ever be regarded as a matter of wonder to future generations that the rulers and merchant princes of the Victorian era, who have derived such splendid benefits from submarine telegraphy, should have permitted two of the noblest of the pioneers of electrical science to thus pass away unnoticed and almost unknown.

Mr. Brett is, however, fortunately a man of happy and cheerful disposition, and feels amply repaid by the knowledge that the subject to which he devoted his early life has now become of almost infinite importance to mankind; that by day and night myriads of signals are ceaselessly flashing through every ocean, and bearing their priceless messages of love or of commerce, of peace or of war. It is a pleasure to feel that when he shall be called away to his last rest he will be sustained by the proud consciousness that he has been enabled to confer greater benefits on his country and on the world than any other man now living.

Subway Inspector.—The London County Council have appointed Mr. F. McMahon, at present assistant inspector of subways, to the position of inspector of subways.

DESCRIPTION OF THE STANDARD VOLT AND AMPERE METER USED AT THE FERRY WORKS, THAMES DITTON.*

BY CAPTAIN H. R. SANKEY (LATE R.E.), MEMBER, AND F. V. ANDERSEN, ASSOCIATE.

(Concluded from page 467.)

5. Measuring Resistances.

With the addition of a few Leclanché cells, with key, and a short-circuit key for galvanometer, the apparatus contains everything required for making Wheatstone bridge tests with good accuracy.

Small resistances—such as the resistance of a dynamo armature or of a brush contact—are taken by a passing current through the resistance, reading simultaneously the amperes passing through it and the P.D. at its ends. The numerous constants given for the ammeter and voltmeter on Tables I. and II. enable the tester to get accurate measurements on this plan with currents differing in strength according to circumstances. The following is an example of a test of the resistance of an armature with different strengths of current:

Amperes. through armature.	Volts between brushes.	Resistance in ohms.
25·9	·203	·00784
47·1	·370	·00786

Insulation resistance can be measured in the ordinary way—by the deflections—by means of the E.M.F. of any available dynamo; and as the value of the current through the galvanometer is read direct, the time usually spent in determining the constant of the galvanometer is saved.

Example:

The E.M.F. of a dynamo running excited without load was measured on the voltmeter galvanometer, G_2, in the ordinary way, and found = 103 volts. The circuit from this dynamo was then opened, and again closed by joining one end of it to the shaft, the other end to the commutator of an armature the insulation of which was to be tested. The volts were again read, the insulating material of the dynamo armature thus forming part of the circuit, which was made direct through G_2—the potentiometer rheostat having been disconnected. The reading on the volt scale was now 89·5—*i.e.*, a current of 89·5 micro-amperes was passing through the circuit.

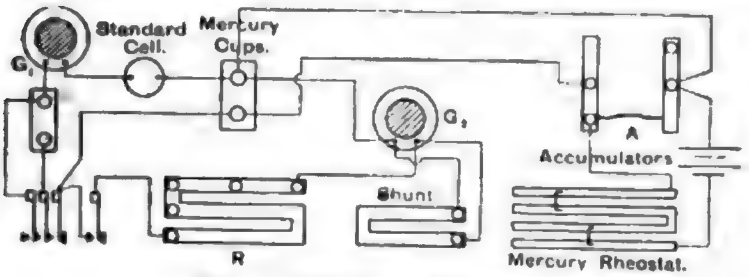


Fig. 1.—Calibrating a Galvanometer.

The total resistance of the circuit was therefore

$$\frac{103 \times 10^6}{89 \cdot 5} \omega = 1 \cdot 151 \text{ megohms},$$

including the insulation resistance + a few hundred ohms resistance of G_2 and leads.

6. Description and Calibration of Instruments.

Galvanometers.—As has been already mentioned, these are of the D'Arsonval type, which was chosen on account of its deadbeatness, and more particularly its independence of variations in the surrounding magnetic field. It is hardly too much to say that a system such as that described in this paper depends on the D'Arsonval galvanometer for its existence. The galvanometers are mounted on a stone supported on thick indiarubber rings, an arrangement which has been found to a large extent to stop the transmission of vibrations. The scales are at a distance of 5ft. from the galvanometers.

Calibration of Galvanometer.—Fig. 1 shows the connections and general arrangement. A current is established by means of two or three secondary cells through two suitable rheostats, one having a fixed and the other a variable resistance, the latter made of mercury placed in grooves of a wooden trough with two copper slides. The strength of this current is varied by adjusting the mercury rheostat until the fall of potential across the fixed resistance—"A" on the diagram, Fig. 1—the terminals of which are connected with two mercury cups on the instrument table, is equal to the E.M.F. of the standard cell. The balance is effected by placing a standard cell joined in series with a second galvanometer in opposition to the P.D. between the two mercury cups, and adjusting the mercury resistance until no deflection is obtained on the second galvanometer. The galvanometer to be calibrated forms with an adjustable resistance-box in series, and generally with a shunt across its terminals, a circuit between the same mercury cups. When no deflection is obtained on the second galvanometer, the fall of potential across the circuit of the galvanometer under calibration is equal to the E.M.F. of the standard cell. Clearly, therefore, the current in the galvanometer can be easily found by means of the formula,

$$c = \frac{e}{m R + G} \quad . \ . \ . \ . \ . \ . \ . \quad (5)$$

c = current through galvanometer.
m = multiplying power of shunt on G.
R = resistance in series with G.
G = ,, of galvanometer.

As a practical matter, the values of R based on the use of a certain shunt are calculated beforehand, so that the current shall be 10, 20, 30 . . . . micro-amperes; and the observations are noted as shown on Table III., which gives the calibration of galvanometer No. 1,588, taken on the 22nd April last.

In the circuit of the standard cell a key is used which has double contacts, and is connected with a high resistance (about 10,000 ohms) in such a manner that, when the key is depressed half way, this resistance prevents an injurious current from passing through the cell, whilst, when the key is completely depressed, after the balance has been very nearly established, the resistance is short-circuited, and so the full sensitiveness of the arrangement obtained.

When the P.D. between the mercury cups is equal to the E.M.F. of the standard cell no current passes through the second galvanometer, the spot of which will move visibly for a current of 1-ten-millionth of an ampere. As the internal resistance of the standard cell plus the resistance of the galvanometer does not exceed 1,600 ohms, a visible deflection is obtained, one way or the other, if the balance is at fault to the extent of $\frac{1}{10^7} \times 1{,}600$, or ·00016 volt, which is about ·011 per cent. of the value of the standard cell.

The mercury varying but little in resistance by temperature, and giving perfect joints with the copper slides, allows of the resistance of the mercury rheostat being adjusted with any desired accuracy, and remaining practically constant when once correctly adjusted. The delicacy of this electrical balance is so great that a movement of 1-64in. of one of the slides is sufficient to cause a deflection on the second galvanometer.

This balance is tried for each reading when calibrating a galvanometer.

Table III.—Calibration of Galvanometer No. 1,588, 22/4, 1891.

Temperature of cell and instruments, 14·5deg. C.
E.M.F. of cell, e = 1·4386 volts (legal).
Resistance of G = 430·9 ohms ,, (measured).
,, of shunt = 47·9 ,, ,, = $\frac{1}{9}$ G.

$$\text{Current in G} = c = \frac{10^5 e}{R + \cdot 1 G} \text{ micro-amperes.}$$

$$\therefore R = \frac{10^5 e}{c} - \cdot 1 G = \frac{143{,}860}{c} - 43 \cdot 1 \text{ legal } \omega \quad . \ . \ . \quad (6)$$

Column II. contains the value of R worked by this formula for the desired value of c in Column I., and Column III. gives the observations obtained in each case; each reading being the mean of three observations.

I. c.	II. R.	III. D mm.	IV. $\frac{\Delta c}{\Delta D}$.
5	28,729	11·3	—
10	14,343	22·8	·4348
20	7,150	45·2	·4464
30	4,752	68·0	·4386
40	3,553	90·9	·4367
50	2,834	113·5	·4425
60	2,355	136·0	·4444
80	1,755·2	180·7	·4474
100	1,395·5	225·0	·4514
120	1,155·7	270·0	·4444
140	984·5	315·5	·4395
160	856·0	361·0	·4395
170	803·1	384·0	·4348

From the calibration in Table III. the volt scale was constructed on the white margin immediately below the millimetre scale by simply projecting the points of the readings in column three downwards by means of a set square and dividing up the sections into units. The ratios $\frac{\text{difference of current}}{\text{difference of deflection}}$ contained in column four of Table III. shows that the deflections are fairly proportional to the currents. Some allowance is to be made for inaccuracies in the millimetre scale apart from errors of observation.

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* Paper read at last week's meeting of the Institution of Electrical Engineers.

The calibration of the ampere galvanometer, G_1, and the manufacture of the ampere scale were done in the same manner as here described.

These calibrations have been repeated several times at intervals, besides which frequent calibrations of mean readings have been taken—formulæ (2) and (4) in the preceding.

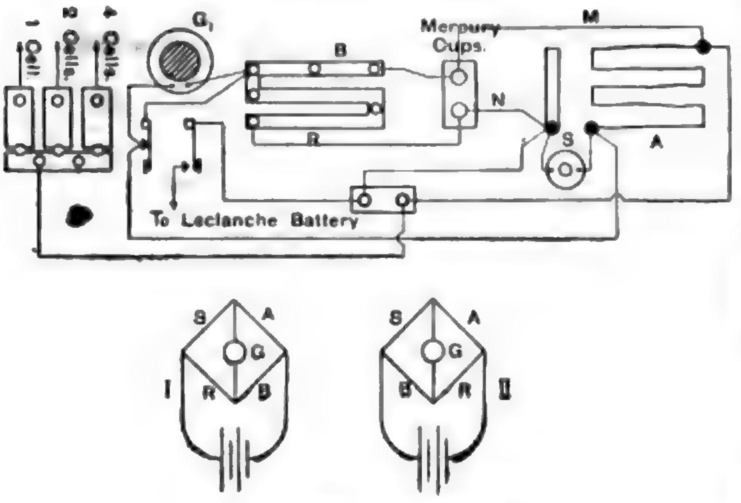

Fig. 2.—Standardising A.

It has been found that the constants of the two galvanometers have not altered beyond 1-5th per cent. during six months, except on two occasions when the levelling of the instruments had been interfered with.

For purposes like these measurements a D'Arsonval galvanometer should have a glass front to the case, so that the coil is clearly visible, and there should be means of verifying and adjusting the position of the coil in the field. The coil should be wound on a metallic (aluminium) frame, to prevent changes in its shape; and there should be a torsion head outside the cover, so that the original zero of the coil in the field can be restored without opening or interfering with the instrument.

As a slight set crept into the suspending wires of the two galvanometers used in the apparatus, and as they had no arrangement for restoring the zero, it became necessary to turn the instruments on their bases, as the position of the scales could not be altered. The effect of the shifting was hardly noticeable on one of the instruments, but it caused an alteration in the constant of the other to the extent of 1·2 per cent., and a discrepancy of ·3 per cent. in the proportionality of the scale, which necessitated regraduating it. An alteration in the constant alone can, of course, at once be balanced by a correction in the resistance used in series with the instrument.

New instruments fulfilling the above conditions are being made.

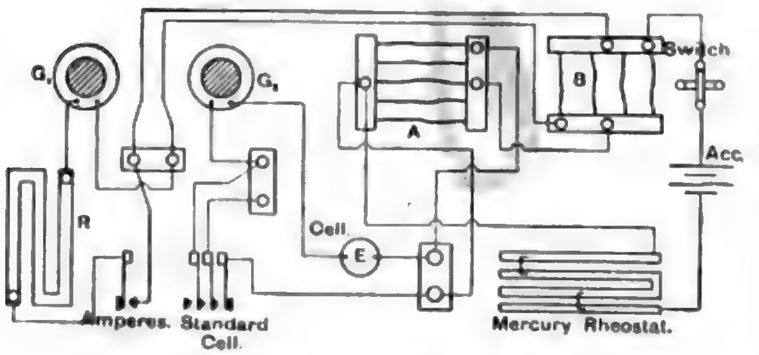

Fig. 3.—Determining B.

Main Ampere-Rheostat.—This rheostat, which is marked B on the diagrams, is made of 40 platinoid strips, 6ft. long each, all joined in parallel between two copper terminal bars. The thickness of the strips is ·03in.; the total width = 38in. The cross-section is 1·14 square inches; the resistance is ·0010882 legal ohm at 17deg. C. The total surface of the strips, including the two terminal bars, is 5,854 square inches. When carrying 1,000 amperes, 1,088·2 watts are consumed by the rheostat—*i.e.*, power is given off to the atmosphere at the rate of ·186 watt per square inch of surface, which has been found to cause a rise of temperature near the centre of the strips of very nearly 20deg. C. The rise of temperature in this rheostat has been observed with different currents, and has been found to be proportional to the square of the strength of the current.

The arrangement used for determining the resistance of B is shown on Diagram 3. It will be seen that B is placed in series with another rheostat, A, and with the mercury rheostat previously mentioned, and that the circuit further contains a few secondary cells. The current in this circuit is adjusted by the mercury slide resistance until the fall of potential across resistance A is equal to the E.M.F. of the standard cell, which is ascertained by means of galvanometer G_2, in the manner described previously when the calibration of the galvanometers was dealt with. The deflection is then read on the scale of galvanometer G_1, which is joined (with a resistance-box in series) across the terminals of B. The resistance of rheostat A, as well as the value of the deflection on G_1, and of the resistance R, in series with it being known, the necessary data for finding the resistance B are to hand. This resistance is obtained from the formula,

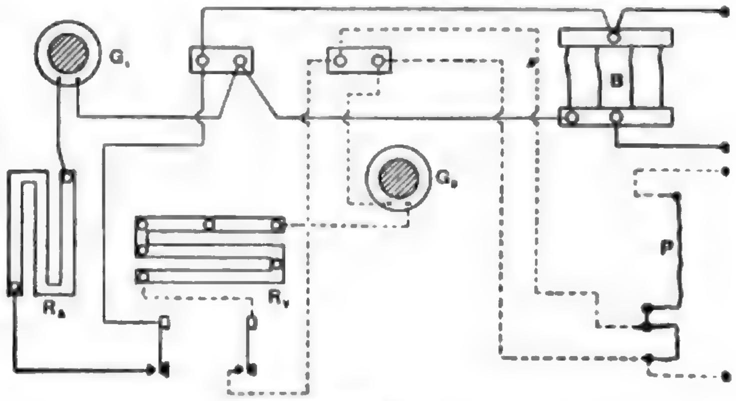

Fig. 4.

$$B = \frac{A}{e} c (G_1 + R)^* \quad . \quad . \quad . \quad . \quad . \quad (7)$$

where e = E.M.F. of standard cell;

c = the current corresponding to the reading on G_1.

Table IV. contains the results of two determinations of B obtained at different dates.

Table IV.—Determination of Resistance of Main Ampere-Rheostat.

Date.	Number of Experiments.	Resistance of B.	Remarks.
2nd April, 1891.	8	·0010882 (reduced to 17deg. C.)	Currents used through B = 29·63 and 49·36 ampere.
21st July, 1891.	3	·0010869 (reduced to 17deg. C.)	Current through B = 49·04.

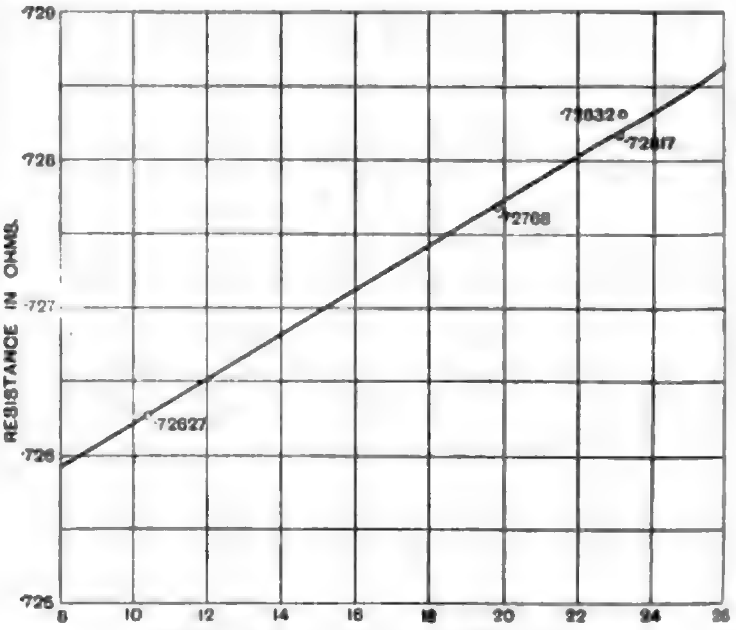

Fig. 5.—Platinoid Rheostat A. (Five Strips in Series.)

Rheostat A.—As is seen from the preceding part of this paper, the accuracy with which currents can be measured in the present system depends upon the knowledge of the value of the resistance of this rheostat. Great care was therefore taken in its manufacture and adjustment. It consists of five strips of platinoid, each intended to carry 10 amperes without material warming. The end of each strip is soldered to a massive gunmetal block let into a wooden frame. These blocks have holes drilled in them about ¾in. diameter for use as mercury cups. Two heavy strips of gunmetal are let into the frame, one at each end, and there are also holes in these strips opposite the holes in the blocks. The connections are made by thick copper bridge-pieces. By this arrangement the strips can be placed either in series or in parallel, and one or more of the strips can be placed in the circuit.

---

* For $\frac{e}{A} B = c (G_1 + R)$.

The resistance of each strip is arranged so that the fall of potential across it when a current of about 10 amperes is flowing through it is equal to the E.M.F. of the standard cell.

The absolute resistance of the strips could have varied within certain limits, but it was necessary to adjust the resistance of each to equality with a considerable degree of accuracy. As there was no means of doing this at Thames Ditton, the resistance was taken to the Ordnance Survey, Southampton, about two years ago, and the adjustment made by scraping the strips until their resistances were equal.

The resistance of the five strips in series was then taken at different temperatures, and as there are special arrangements at Southampton for keeping the temperature of the testing-room constant, the temperature of the platinoid strips could be accurately determined at the time when each resistance test was taken. The results of these tests are given in Fig. 5. The balance was made against the Ordnance Survey standard ohm (legal).

At Thames Ditton the resistance of the strips has been determined from time to time by a direct comparison with the Thames Ditton standard ohm in the manner shown in Fig. 2. It will be seen that the resistance and the ohm form two arms of a Wheatstone bridge arrangement, and boxes of coils the other two arms, as shown by the two small figures (1) and (2). The adjustable resistance, R, is first placed in one arm, and then in the other, so that the resistance, A, of the strips is found by the equation,

$$A = S\sqrt{\frac{R_2}{R_1}} \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

where

S = the resistance of the standard ohm at the given temperature ;

R_1 and R_2 the values of the adjustable coils in the first and second measurements respectively.

The only alterations required in the connections in going from the first of the two tests to the second is the changing of the two leads, M and N, in the mercury cups.

It will be observed that by this arrangement no allowance has to be made for leads, and the absolute resistance of the box of coils is immaterial. True proportionality only is required; thus the temperature of the box of coils does not affect the result.

Fig. 5 shows that the resistance of the five platinoid strips rose from ·7262 ohm to ·7280 ohm for a rise in the temperature from 10deg. to 22deg. C., which gives a temperature coefficient of ·0207 per cent. per degree centigrade. At 14·8deg. C., the value, according to the tests at Southampton, is ·72693. The test at Thames Ditton gave ·72659, leaving a discrepancy of ·047 per cent.

Surface Leakage.—One way of quickly making a test of the state of the instruments is to send a current from the testing cells through the rheostat B, with the connections as in Fig. 3, which, when the instruments are not in use for other purposes, can be done by merely turning on a switch, and read the value of this current on the ampere galvanometer with various constants, altering the resistances in series, according to Table I. When this experiment was tried after the instruments had been out of use during the Easter holidays, the galvanometer gave a higher value for the current with constant ·5 than with constant 1, and with constant ·1 still a higher value than with ·5. This discrepancy, which amounted to no less than 3 per cent., was found to be due to surface leakage, which was greater with the higher constant obtained by higher resistance in series. It disappeared completely by a slight rubbing of the top of the resistance-boxes with a piece of leather.

The considerable error mentioned was obtained with a current of about 40 amperes, producing a P.D. across the instruments of only about ·043 volt.

TRADE NOTES—ELECTRICAL AND MECHANICAL.

The great increase in laying of mains necessitates new tools. Designs and improvements in tools are of constant occurrence, and many manufacturers have had special tools made to assist workmen who use their productions. This is the case with the Fowler-Waring Company, which issues a set of jointing tools, as shown in the illustrations. Fig. 1 shows a lead-cutting tool to take the place of the pocket knife, saving time, trouble, and danger to insulation. Fig. 2 is a tool for making a circular cut in the lead, and Fig. 3 is a tool for stripping insulation from wires up to No. 10 S. G.

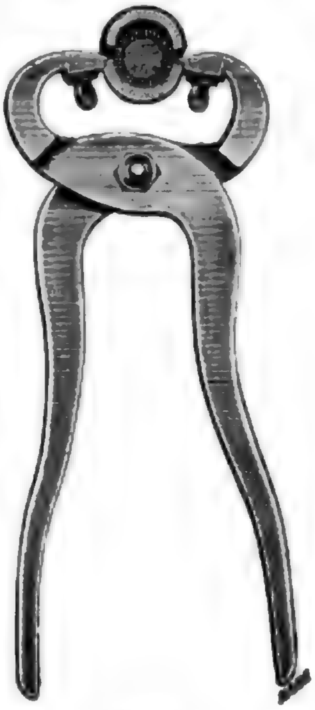

Fig. 1.

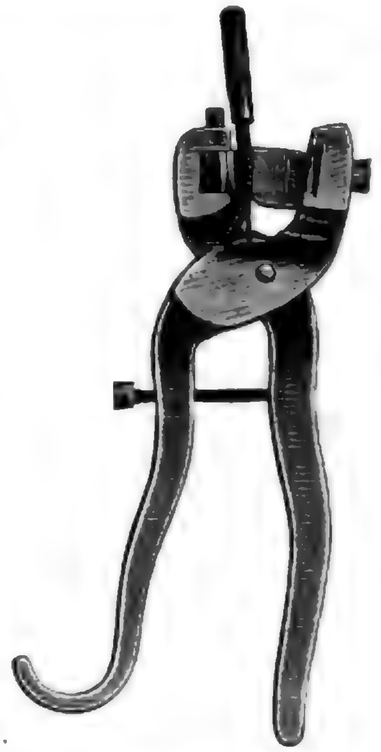

Fig. 3.

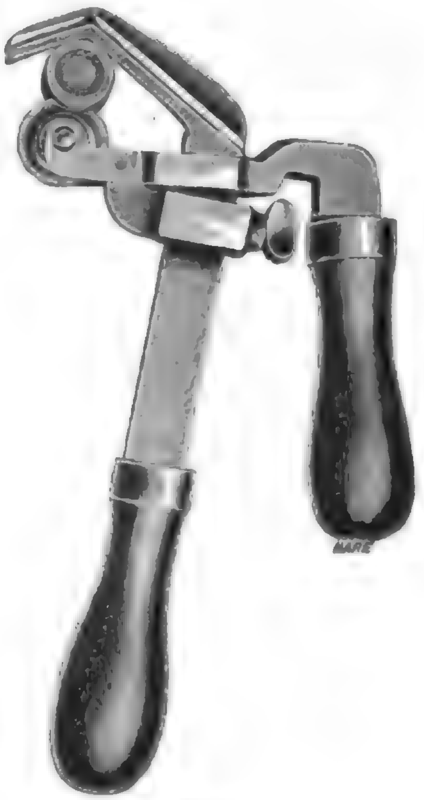

Fig. 2.

Royal Meteorological Society.—The first meeting of the present session was held on Wednesday evening, at the Institution of Civil Engineers, Mr. Baldwin Latham, M.I.C.E., president, in the chair. Amongst other papers was an "Account of an Electric Self-recording Rain Gauge," by Mr. W. J. E. Binnie, B.A. This was the description of a very ingenious instrument, constructed on the assumption that all drops falling from a orifice or tube are identical in weight, as long as the dimensions of the orifice are not varied, the indications being recorded electrically.

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All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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TO CORRESPONDENTS.

Gone Missing.—*We have received, with the postmark "Birmingham," a label addressed to us (1½d. stamp) with nothing attached thereto. If any correspondent can identify his communication, perhaps he will kindly enquire at Birmingham or send again.*

WOODHOUSE AND RAWSON.

A glance through the report of the meeting of this company will show that some of the shareholders are a little uneasy as to the balance-sheet. It is a fine thing to get a dividend at the rate of 15 per cent. for the ordinary shareholder, and at first sight is a thing which merits applause. We shall not say at present that it merits aught else, but before committing ourselves either way, we should like to see a list giving details of the sundry investments of £119,338; also the reasons for appraising the value of "goodwill" at £98,000. It is now a little over twelve months since we ventured to call attention to the balance-sheet of 1890. The departure we were the first to introduce in giving the figures of the balance-sheet enables our readers to make comparison of the new with the old. The balance-sheet of 1890 will be found in our issue of Oct. 10, 1890, that of 1891 in the issue of Nov. 13 last. It will be found that the share capital authorised in 1891 is £200,000 more than in 1890. The practical capital in 1890 was £321,322; in 1891 it had risen to £522,999, an increase in the year of £201,677. The profit made as per balance-sheet 1890 was £61,085, but the profit made during the past year with over £200,000 more capital was only £51,439, nearly £10,000 less. The attention of directors and shareholders was last year called in our issue of Oct. 17 to the hazardous nature of the business of floating subsidiary companies to obtain a dividend; in fact, to the danger of finance as against strictly commercial pursuits. Further consideration of the balance-sheet shows that the value of freeholds has increased from £53,200 to £65,131 within the year, though it is not shown that any new freeholds have been acquired. The questions are therefore legitimate, Has the value been written up by some of this £12,000, and why, or is this the cost of extensions? Similarly leaseholds have increased £553, while plant and machinery, etc., jumps from £17,000 to over £31,000. Again the question may be asked, How has this extra £14,000 been arrived at? Stock, etc., has increased from £73,000 to £126,000. The estimated value of patents has risen £10,000, and goodwill £8,000, while cash in hand is only £6,000, as against £51,500, but this latter is partly accounted for to the extent of about £33,000 by increase of book debts.

Broadly speaking, then, the capital account for the year increased by £200,000, requiring £10,000 to pay 5 per cent. This capital has been spent thus:

Freeholds	£12,000
Leaseholds	550
Plant	14,000
Stock, etc.	53,000
Patents	10,000
Investments	108,000
	£197,550

From this it will be seen that "investments" must play a most important part in the future of this company. A legitimate trading concern has no "investment" except "reserve." Hence we must, whether we will or no, look upon "Woodhouse and Rawson" as a huge syndicate for company promotion, and probably a large part, if not the whole, of their "investments," consists of shares in companies promoted. There is one other item in the balance-sheet to which attention must be directed. Salaries in 1891 claim £15,208. 8s. 8d., while in 1890 the similar item read, "Salaries, including managing director's and manager's commission, £23,269. 14s. 1d." There has been a decrease of over £8,000 in the year. Is this represented by "directors' and manager's commission"? Since the meeting, a full report of which appears elsewhere, the public has been asked to subscribe further capital to the tune of £175,000, though it is stated that a part of this only will be called up—namely, £145,000. Of course, great care has been taken that none of the papers which might be expected to know something of electrical work can criticise this new call for capital. It matters little to others whose view is limited to dividends paid. They do not and they cannot well analyse the prospects of such a company.

The most conspicuous promotions of Woodhouse and Rawson are "The Elmore Companies" and "The Okonite Company." Large sums have thus been netted by the promoters for these companies "floated," though as yet they are not conspicuous by success; but unless the "investments" can be advantageously unloaded there seems to be every probability of great depreciation, and then this item in the balance-sheet becomes a more and more doubtful asset. It may be that we are wrong about the "investments." For the sake of shareholders we trust it is so. Caution, however, is necessary, and never more so than when with £200,000 extra capital profits decrease, and with a "steady and progressive increase of electrical work" a diminished expenditure on salaries does not prove where the advantages to this company come in. It is easy, very easy, to have glowing balance-sheets, when with almost every recurring balance-sheet the generous public come forward eagerly with contributions to capital.

Let us turn for a moment from the consideration of balance-sheets and promotion of companies to a phase in this company's work which has always had our heartiest sympathies. The intense energy displayed, the far-sighted policy of planting everywhere in electrical circles the imprint of "Woodhouse and Rawson," must have resulted in forming the nucleus of an enormous business, which, if carefully nursed and discreetly conducted, will lay the foundation of a great success. It is absolutely impossible, however, that the same attention can be given to commercial details when time is occupied over promotion, as if the whole time was concentrated upon these details. We are not among those who look askance at the increase of manufacturing departments, and ofttimes such increase leads to a considerable accession of business, from the fact that the goods work in with each other. Success, however, depends upon organisation and supervision.

LONDON COUNTY COUNCIL v. ST. PANCRAS.

It is rather hard upon the St. Pancras authorities to be placed in the position they have been placed through the action of the London County Council. The late Metropolitan Board of Works and the London County Council hold a position somewhat analagous to that of a bank—in that they lent or lend money to other local authorities at a moderate rate of interest. The St. Pancras authorities decided—and we think justly—to carry out a central station installation under a provisional order, and applied to the County Council for a loan of some £60,000. The Finance Committee of the Council sent up a report recommending under certain conditions the granting of a loan. These conditions were not the conditions of St. Pancras—but on that we have nothing at present to say. As soon as the report was before the Council it was asked to be referred back. This is the point to which we direct attention. The Finance Committee did or did not know its mind, and understood its business, and made its report after due discussion and examination, so that the consideration of the points referred back ought to have been settled before the report was presented. No doubt an effort will be made to get over the troubles which may arise because of the delay, but the whole thing is unbusinesslike. The committee may have met and decided in time to allow of an application to Parliament, and a compliance with the Standing Orders, if the decision is unfavourable. On the other hand, the decision may be favourable; but the decision of the whole Council unfavourable. To be on the safe side, St. Pancras must apply to Parliament; though the authorities may be perfectly certain the application is unnecessary, and next Tuesday—or a week too late—the County Council may agree to what is required.

THE INSTITUTION DINNER.

The third annual dinner of the Institution was held on Friday, November 13, at the Criterion, Regent-street, Piccadilly, under the chairmanship of the President, Prof. W. Crookes, F.R.S. The following members and guests were present, besides the representatives of the Press. The following technical papers were represented: The *Electrician*, by Mr. W. Moore; the *Electrical Review*, by Mr. H. Scholey; the *Electrical Engineer*, by Mr. W. M. Bowles; the *Engineer*, by Mr. W. W. Beaumont; *Engineering*, by Mr. Raworth, and *Industries* by Mr. Swinburne; Sir F. Abel, Mr. Abercrombie, Prof. W. G. Adams, Major G. W. Addison, R.E., Mr. Alabaster, Mr. Albright, Mr. Anderson, Mr. Ardron, Prof. Ayrton, Mr. Bailey, Sir Benjamin Baker, Mr. Graff Baker, Mr. Beaumont, Mr. Berkley, Mr. Berly, Mr. C. H. W. Biggs, Mr. G. Binswanger, Mr. M. Binswanger, Mr. Blackwell, Sir T. Blomefield, Dr. Borns, Mr. Bristow, Mr. Buckney, Sir A. Cappel, Major Cardew, R.E., Mr. Carey, Mr. Chambre, Mr. Chaney, Mr. Clark, Mr. Claremont, Mr. Clirehugh, Mr. H. Cooke, Staff-Commander Creak, Mr. Crompton, Mr. J. Crookes, Mr. Cunliffe-Owen, Mr. Curtis-Hayward, Mr. Cushing, Mr. D'Alton, Mr. Despecher, Mr. Down, Mr. Dowson, Colonel Du Plat Taylor, Mr. Duthy, Mr. Edmunds, Mr. Elphinstone, Mr. Erskine, Mr. Esson, Mr. Evans, Mr. Fairfax, Mr. Ferranti, Mr. Fleetwood, Dr. Fleming, Mr. Fletcher, Mr. Glegg, Mr. Gordon, Mr. Gorham, Mr. Graham, Lieut.-General Grant, Mr. A. Graves, Mr. E. Graves, Mr. Gray, Mr. Grindle, Mr. Hammar, Mr. R. Hammond, Mr. C. P. Hammond, Mr. Harrison, Dr. Hassard, Major Hassard, Mr. Hayter, Colonel W. Haywood, Mr. R. Heard, Mr. A. W. Heaviside, Mr. B. Heaviside, Mr. Hedges, Mr. Hesse, Mr. Hirst, Captain R. A. Holden, Mr. Holt, Prof. Hughes, Mr. Hughes, Colonel Jackson, Mr. Jarmin, Mr. Jenkin, Mr. Jones, Mr. Kapp, Mr. Kempe, Mr. E. W. Knight, Mr. E. R. Knight, Mr. Lamb, Mr. Larkin, Mr. McKenna, Mr. Macrory, Sir H. Mance, Mr. Mavor, Mr. Morrison, Mr. Morse, Mr. Lee Murray, Mr. F. H. Nalder, Mr. N. F. Nalder, Mr. Paget, Mr. Patridge, Mr. Payne, Mr. Payton, Mr. Pell, Sir J. Pender, Mr. Piper, Mr. Preece, Mr. G. E. Pritchett, Mr. G. E. B. Pritchett, Mr. W. Rawlins, Mr. F. Rawlins, Sir R. Rawlinson, Mr. Reckenzaun, Mr. Reid, Mr. Rivington, Mr. Robertson, Mr. Robinson, Commander Rogers, Earl Russell, Sir D. Salomons, Captain R. E. Sankey, Mr. Sellon, Mr. Sharp, Mr. Sherrin, Mr. Siemens, Mr. Simkins, Mr. Snell, Mr. C. E. Spagnoletti, Mr. J. Spagnoletti, Captain Stiffe, Sir G. G. Stokes, Mr. Stothert, Captain R. E. Stuart, Mr. Swinton, Mr. Tralen, Mr. de Tunzelmann, Mr. Vorley, Mr. Wallace, Mr. Webb, Mr. March Webb, Major-General Webber, Mr. Wilson, Captain Wharton.

The first toast was the usual one of "The Queen," proposed by the CHAIRMAN, who said :

In proposing the health of our Sovereign, we cannot forget that her Majesty's sympathies have always been extended to the physical sciences, and to all movements for their cultivation and extension.

Electricity is eminently a Victorian science. At the date of her Majesty's coronation, it was a curiosity for the few. It is now the useful servant of the many. May the Queen long live to witness further developments.

The next toast was that of "The Prince and Princess of Wales," etc., which was proposed by the CHAIRMAN in the following words :

Within the last few days his Royal Highness has been celebrating a "purely domestic event," and receiving congratulations—congratulations in which I am sure we all fervently join. To reach one's fiftieth birthday is perhaps not altogether a matter for joy bells. When Bret Harte was felicitated on his fiftieth anniversary, he replied he could understand a man shooting at his best friend from behind a hedge, but he could not understand being congratulated on being fifty. But the Prince is still in the prime, young in heart, and is clearly of opinion that this life is worth living.

It is well known that the heir to the Crown is one of the most hard-working men in the whole British Empire, though we do not learn that he has yet put in his claim for a day of eight hours. He would be the first to admit how much he personally owes to the ingenuities of electricians, through whose aid he is able to keep pace with his complicated daily programme.

We are all aware of the Prince's warm interest in the Imperial Institute, one of whose main functions is the extension of science. Hence we may greet in the Prince a friend and a colleague.

Again the CHAIRMAN'S task was to propose "The Navy, the Army, and the Reserve Forces," which he did in the following words :

Some thinkers and dreamers to-day have arrived at the conclusion that soldiers and sailors are a superfluity, and that if an invading army were to meet with no opposition, it would feel ashamed of itself, and peacefully retire without plundering, requisitioning, without claiming indemnities, or seizing any part of our territories. Before trying this interesting experiment on our country we should prefer to see it carried out elsewhere. Whilst awaiting the realisation of this peace-on-earth Utopia, we are bound to take a lively interest in the efficiency of our defenders by land and sea. To keep our army and our navy in a state of efficiency, the services of the electrical engineer are indispensable.

Electricity has revolutionised the art of warfare as much as did the invention of gunpowder. By the facility which it affords for massing large army corps at the point threatened, and of rapidly concentrating mighty fleets from all quarters of the globe in some narrow sea—say the Channel—it has quadrupled our fighting powers. It supplies us with searchlights for discerning the stealthy approach of an enemy, and with instantaneous means of exploding mines and torpedoes. A modern ironclad, more complicated than a central lighting station, demands in its superior officers the training of electrical engineers.

Capt. WHARTON responded for the Navy, and referred to the increasing number of uses to which electricity was applied on board ship.

Lieut-General GRANT replied for the Army, and followed the lead of Capt. Wharton in describing the uses to which electricity was put in military work.

Colonel DU PLAT TAYLOR in an amusing speech replied for the Reserve Forces.

The CHAIRMAN followed with the toast of "Electricity in Relation to Science." He said :

We have happily outgrown the preposterous notion that research in any department of science is mere waste of time. It is now generally admitted that pure science, irrespective of practical applications, benefits both the investigator himself, and greatly enriches the community. "It blesseth him that gives and him that takes." Between the frog's leg quivering on Galvani's work-table and the successful telegraph or telephone there exists a direct filiation. Without the one we could not have the other.

We know little as yet concerning the mighty agency of electricity. "Substantialists" tell us it is a kind of matter. Others view it, not as a matter, but as a form of energy. Others, again, reject both these views. Prof. Lodge considers it "a form, or rather a mode of manifestation, of the ether." Prof. Nikola Tesla demurs to the view of Prof. Lodge, but thinks that "nothing stands in the way of our calling electricity ether associated with matter or bound ether." High authorities cannot even yet agree whether we have one electricity or two opposite electricities. The only way to tackle the difficulty is to persevere in experiment and observation. If we never learn what electricity is, if like life, or like matter, it should remain an unknown quantity, we shall assuredly discover more about its attributes and its functions.

The light which the study of electricity throws upon a variety of chemical phenomena—witnessed alike in our little laboratories and in the vast laboratories of the earth and the sun—cannot be overlooked. The old electro-chemical theory of Bercelius is superseded, and a new and wider theory is opening out. The facts of electrolysis are by no means either completely detected or co-ordinated. They point to the great probability that electricity is atomic, that an electrical atom is as definite a quantity as a chemical atom. The electrical attraction between two chemical atoms being a trillion times greater than gravitational attraction is probably the force with which chemistry most deeply concerned.

It has been computed that in a single cubic foot of the ether which fills all space, there are locked up 10,000 foot-tons of energy which have hitherto escaped notice. To unlock this boundless store and subdue it to the service of man is a task which awaits the electrician of the future. The latest researches give well-founded hopes that this vast storehouse of power is not hopelessly inaccessible. Up to the present time we have been acquainted with only a very narrow range of ethereal vibrations, from extreme red on the one side to ultra-violet on the other—say, from three ten-millionths of a millimetre to eight ten-millionths of a millimetre. Within this comparatively limited range of ethereal vibrations, and the equally narrow range of sound vibrations, we have been hitherto limited to receive and communicate all the knowledge which we share with other rational beings. Whether vibrations of the ether, slower than those which affect us as light, may not be constantly at work around us, we have until lately never seriously enquired. But the researches of Lodge in England and Hertz in Germany give us an almost infinite range of ethereal vibrations or electrical rays from wave-lengths of thousands of miles down to a few feet. Here is unfolded to us a new and astonishing universe—one which it is hard to conceive should be powerless to transmit and impart intelligence.

Experimentalists are reducing the wave-lengths of the electrical rays. With every diminution in size of the apparatus the wave-lengths get shorter, and could we construct Leyden jars of molecular dimensions the rays might fall within the narrow limits of visibility. We do not yet know how the molecule could be got to act as a Leyden jar, yet it is not improbable that the discontinuous phosphorescent light emitted from certain of the rare earths, when excited by a high-tension current in a high vacuum, is really an artificial production of these electrical rays, sufficiently short to affect our organs of sight. If such a light could be produced more easily and more regularly, it would be far more economical than light from a flame or from the arc, as very little of the energy in play is expended in the form of heat rays. Of such production of light, Nature supplies us with examples in the glow-worm and the fire-flies. Their light, though sufficiently energetic to be seen at a considerable distance, is accompanied by no liberation of heat capable of detection by our most delicate instruments.

By means of currents alternating with very high frequency, Prof. Nikola Tesla has succeeded in passing by induction through the glass of a lamp energy sufficient to keep a filament in a state of incandescence without the use of connecting wires. He has even lighted a room by producing in it such a condition that an illuminating appliance may be placed anywhere and lighted without being electrically connected with anything. He has produced the required condition by creating in the room a powerful electrostatic field alternating very rapidly. He suspends two sheets of metal, each connected with one of the terminals of the coil. If an exhausted tube is carried anywhere between these sheets, or placed anywhere, it remains always luminous.

The extent to which this method of illumination may be practically available experiment alone can decide. In any case, our insight into the possibilities of static electricity has been extended, and the ordinary electric machine will cease to be regarded as a mere toy.

Alternating currents have at the best a rather doubtful reputation. But it follows from Tesla's researches that as the rapidity of the alternation increases they become not more dangerous but less so. It further appears that a true flame can now be produced without chemical aid—a flame which yields light and heat without the consumption of material and without any chemical process. To this end we require improved methods for producing excessively frequent alternations and enormous potentials. Shall we be able to obtain these by tapping the ether? If so, we may view the prospective exhaustion of our coalfields with indifference; we shall at once solve the smoke question and thus dissolve all possible coal-rings.

Electricity seems destined to annex the whole field not merely of optics, but probably also of thermotics.

Rays of light will not pass through a wall, nor, as we know only too well, through a dense fog. But electrical rays of a foot or two wave-length of which we have spoken will easily pierce such mediums, which for them will be transparent.

Another tempting field for research, scarcely yet attacked by pioneers, awaits exploration. I allude to the mutual action of electricity and life. No sound man of science endorses the assertion that "electricity is life," nor can we even venture to speak of life as one of the varieties or manifestations of energy. Nevertheless, electricity has an important influence upon vital phenomena, and is in turn set in action by the living being, animal or vegetable. We have electric fishes—one of them the prototype of the torpedo of modern warfare. There is the electric slug which used to be met with in gardens and roads about Hornsey Rise; there is also an electric centipede. In the study of such facts and such relations the scientific electrician has before him an almost infinite field of enquiry.

The slower vibrations to which I have referred reveal the bewildering possibility of telegraphy without wires, posts, cables, or any of our present costly appliances. It is in vain to attempt to picture the marvels of the future. Progress, as Dean Swift observed, may be too fast for endurance. Sufficient for this generation are the wonders thereof.

Sir G. G. STOKES, Bart., M.P., replied, and regretted the absence of Sir W. Thomson, who might otherwise have undertaken the responsibility of the reply. The numberless points of contact of electrical with other branches of science were referred to, and brief mention made of the development of the dynamo from the time of Faraday's experiment to the present. References were also made to our want of knowledge of what electricity really is, to its intimate connection with chemical union and chemical decomposition, to the discoveries of Faraday, Clerk Maxwell, Lodge, and Hertz.

Mr. C. E. SPAGNOLETTI (past president) then proposed "Electricity in its Practical Application," when he as rapidly as possible scanned the most important applications, and to this Sir J. PENDER replied.

Mr. W. H. PREECE (past president) in a humorous speech proposed "Our Guests," to which the president of the Institution of Civil Engineers (Mr. G. BERKLEY) replied.

Then came the toast of the evening, proposed by Sir G. G. STOKES in well-chosen language, and responded to by the CHAIRMAN as follows:

Without unjustifiable vanity I may be allowed to say that the Electrical Engineers have abundantly justified their existence. But instead of smooth prophecies or perching on the highest "dead wire" and crowing, it may be better to take a bird's-eye view of the solid work that lies ahead. I have already referred to certain unsolved problems of electric energy. In the list of momentous problems the action of electricity on animal and vegetable life is not the least important. As regards the treatment of disease the subject is temporarily overclouded by falling into the hands of advertising quacks. In respect to vegetation it is still uncertain whether electrical currents exercise any decided or uniform influence upon growing crops of grain and fruit; whether such influence would be favourable or the reverse. Recent experiments lead to the opinion that electricity may induce earlier and better harvests. But much further study is here needed. Nor have we yet solved the equally important and closely connected question, whether we may by electrical action rout the parasitical insects and fungi which in some seasons rob us of no less than the tenth of our crops. A moderate estimate puts the mean loss in the home kingdoms at £12,000,000 per annum. In India and the colonies a number of destroyers, which it is not my business to specify, are less easily contented. Like Falstaff, in the words of Dame Quickly, they seek to take "not some, but all." The attacks of the phylloxera have cost our French neighbours more than did the Franco-Prussian War.

It has been found out in not a few experiments that electric currents not only give increased vigour to the life of the higher plants, but tend to paralyse the baneful activity of parasites, animal and vegetable. Here there is unlimited scope for practical research, in which the electrical engineer must join forces with the farmer, the gardener, and the vegetable physiologist. We have definitely to decide whether, and under what circumstances, electricity is beneficial to our crops; and whether, and under what conditions, it is deadly to parasitic pests. Here, then, comes the question of a supply of electricity cheaper and more universally applicable than the tedious conversion of chemical energy into heat, of heat again into mechanical power, and of such power into electric current. It is depressing to reflect that this roundabout process, with losses at every step, is still our best means of obtaining a supply of electricity. Whilst seeking for cheaper sources of electricity, no endeavour must be spared to tame the fierceness of those powerful alternating currents now so largely used. Too many clever electricians have shared the fate of Tullus Hostilius, who, according to the Roman myth, incurred the wrath of Jove for practising magical arts, and was struck dead with a thunderbolt. In modern language, he was simply working with a high-tension current, and inadvertently touching a live wire, got a fatal shock.

With regard to the possible applications of electricity to agriculture, I may mention that the total amount of *vis viva* which the sun pours out yearly upon every acre of the earth's surface, chiefly in the form of heat, is 800,000 h.p. Of this mighty supply of energy a flourishing crop utilises only 3,200 h.p., so that the energy wasted per acre of land is 796,800 h.p. We talk loudly of the importance of utilising the refuse of our manufactures; but what is the value of alkali waste, of furnace slags, of coal-tar, or all of them together, compared to the loss of 796,800 h.p. per acre of land?

The application of electricity to sanitary improvements is another possibility, turning mainly on a cheap supply of current. The electric treatment and purification of sewage and industrial waste water is a demonstrated reality which merely requires a reduction in the cost of the agent employed.

The sterilisation by electrical means of the water supply of cities has been proposed and discussed. Theoretically it is possible, but the practical difficulty of dealing with the vast volumes of water required for the daily consumption of London is prodigious. But a difficulty, said Lord Lyndhurst, is a thing to be overcome. There is a still more important consideration; the living organisms of water are by no means all pathogenic. Many are demonstrably harmless, and others possibly beneficial. Pasteur proposed to bring up young animals on sterilised food and drink with a view to determine whether their health and development would be affected for the better or for the worse. Decisive results are not as yet forthcoming. Before the sterilisation of our water sources can be prudently undertaken, this great question must first be decided by experimental biologists.

Another point at which the practcial electrician should aim is nothing less than the control of the weather. We are told these islands have no climate—merely samples, that an English summer consists of "three fine days and a thunderstorm," and that the only fruit that ripens with us is a baked apple. There is more than a grain of truth in the sarcasm. The great evil of a thunderstorm in this country is not that the lightning may kill a man or a cow, or sets barns or stacks on fire. The real calamity consists in the weather upset. The storm is followed by a fall of temperature, and a fit of rain, clouds, and wind, which rarely lasts less than a week, sadly interferes with the growth and ripening of grain and fruits. The question is, cannot the accumulations of electric energy in the atmosphere be thwarted, dispersed, or turned to practical use? In like manner we may hope to abate the terrible fog nuisance.

We hear of attempts at rain-making more or less successful. Shall we ever be able to put an end to a perennial drizzle?

I shall perhaps be styled dreamer if I hint at the possibility of still further amending the ways of Providence. We all know too well that cloudiness and rainfall occur chiefly by day, and clear skies at night. This is precisely the opposite arrangement suitable to vegetation. As we have just seen, Nature supplies energy amply sufficient. How is this prodigious quantity of power to be made available? These are problems that may safely be left to the devices and inspirations of our electrical engineers.

I am perplexed how best to acknowledge the honour you have done me. I am no speech maker. I have been accustomed to deal with things, their properties and changes, rather than with words. But pray do not suppose I am at all indifferent to your kindness. Sympathy is no less dear to the strugglers of science than to those engaged in other more popular pursuits. It is, perhaps, more dear, because, as is only natural, our work inevitably appeals to the few, not to the many.

I have given you some indication of the intricate problems to be handled, of enormous difficulties to be surmounted. What is really in store in the way of future wonders is folded "in shady leaves of destiny."

WOODWARD AND EVANS'S PATENT.

We were agreeably surprised to find our excellent contemporary the *Electrical Review* had at length scented out "Woodward and Evans's" patent. The news that this patent existed is old to our readers, as it was referred to in our issue of April 26, 1889, and we are therefore fain to claim the credit of being first to direct attention to the subject of this invention. A copy of the specification was in our hands at the time the record was made, but we were asked not to publish it for reasons we could not then nor even now understand, yet we complied with the request. The specification, however, is still in our hands, as is the sheet of drawings. We therefore do not longer hesitate to give the text of the specification, and most of the drawings—only two of which, however, seem pertinent to the subject of priority of patents; especially as regards what was so long termed "division of light." It has always seemed to us that the claims of Sawyer-Mann, of Maxim, of Edison, of Lane Fox, and of a host of others are not worth a rap when considered in connection with this specification and drawings. The incandescent lamp patents themselves are of little value without a parallel system of distribution, and we contend now, as we contended before, that so far as our historical researches go, Woodward and Evans were the first to obtain a patent which is the master patent of all that have followed. Woodward is a Birmingham man, and it would be interesting to know why this patent has so long remained hidden to patent agents and lawyers.

DEPARTMENT OF AGRICULTURE.

Patent Office, Ottawa, Canada,
August 5, 1886.

Certified to be true and correct copies of the original specification and drawings remaining on record in this office, duplicate copies of which were attached to a patent, No. 3,738, bearing date the 3rd day of August, 1874, and granted to Henry Woodward and Mathew Evans for 15 years from the said date in the Dominion of Canada, for "Improvements on the art or process of obtaining artificial light by means of electricity" (the partial fee for a term of five years having been paid on said patent).

As witness the seal of the Patent Office hereto affixed.

H. CASGRAIN,
Acting Deputy Commissioner of Patents.

SPECIFICATION.

To All whom it may Concern.

Be it known that we, Henry Woodward, of the city of Toronto, in the county of York, in the province of Ontario, medical electrician, and Mathew Evans, also of the city of Toronto, in the county of York, in the province of Ontario, gentleman, have jointly invented new and useful improvements in the art or process of obtaining artificial light by means of electricity, and we do hereby declare that the following is a full, clear, and exact description of the same:

In the first place, we use a gas engine, or other suitable motive power for the purpose of rotating a magneto-electric machine, and at such velocity as shall create electricity sufficient to heat certain pieces of carbon to a state of incandescence.

In the second place, we use "pure carbons," and place the same in lamps, or other suitable vessels, as hereinafter described.

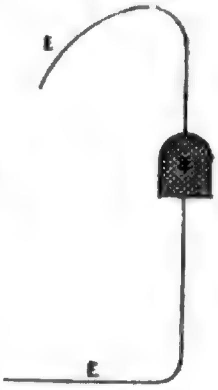
A piece of carbon, as hereinbefore mentioned, pure in quality, and of suitable size, proportioned to the size of lamp or vessel to be used, is scraped and shaped until fitted for the purpose. One electrode is then connected with the carbon at the top, and the other electrode is connected with the carbon at the bottom in the following manner.

A small hole is drilled a short distance into each end of the carbon to fit the electrodes, and when necessary they are further secured by surrounding them with a portion of plaster of Paris or other suitable substance, the electrodes not passing through the carbons, nor connecting with each other. It is then enclosed in a globe, or other vessel, either of glass or other suitable material. The air is then extracted from the said globe, or vessel, after it has been hermetically sealed at the ends, and then filled with rarefied gas that will not unite chemically with the carbon when hot. Electricity is now supplied and in sufficient quantity so as to heat the carbon within the vessel to a state of incandescence, the rarefied gas previously introduced now becomes luminous, and constitutes the light herein designated as Woodward and Evans's electric light.

This process will give a light of any required intensity, and there is practically no limit to the number of lights that may be obtained from one magneto-electric machine.

FIG. 1

FIG. 2.



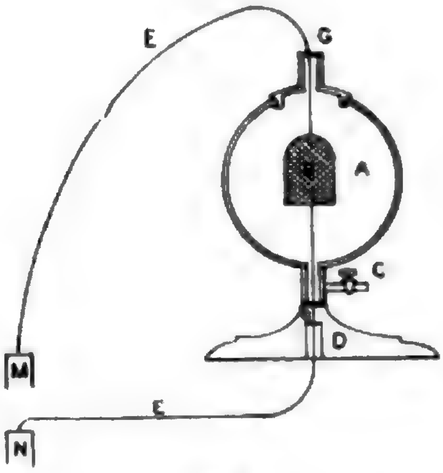


FIG. 3.

In the accompanying drawings, the same letters of reference indicate the same parts in all the views, and also in the specification.

Fig. 1 is an elevation, or front view of a piece of carbon, and is marked B; it is supposed to be scraped and shaped until suitable for the required purpose.

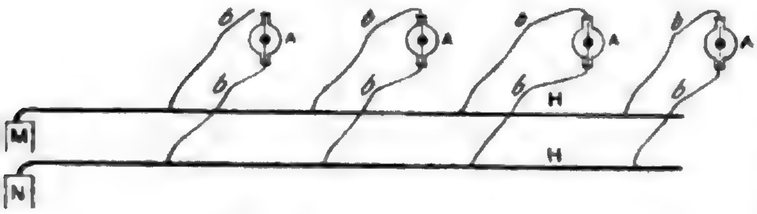
Fig. 2 is also an elevation or front view of the same piece of carbon with the electrodes, E E, attached thereto, leading to and from the positive and negative poles of the battery, one being attached at the top and the other at the bottom of the carbon.

Fig. 3 is a sectional elevation, showing globe marked A, but which may be a vessel of any other suitable form. The prepared carbon, B, is also shown therein, and the aforesaid electrodes, E E, attached thereto, showing also a tube, C, with an air-tight stopcock to be used in exhausting the air from the globe or vessel, A, and also for the injection of rarefied gas into the same. Showing also the hermetical sealing of said vessel at the ends of the tubes and marked G G; and showing also the stand, D.

Fig. 4* is also a sectional elevation, showing the adaptation of another form of vessel, A. This drawing is on a larger scale, in order to show the manner of closing the ends of the vessel, which is done by brass sockets—that at the top being marked K, and that at the bottom L; showing also the carbon, B, different in form than that in the other vessel, and the two electrodes, E E, running to and from the poles, M N.

Fig. 5 is an elevation, showing one mode of connecting the various lights with the machine by means of two trunk wires, or electrodes, H H, running from the positive and negative poles, M and N, of the machine, with branches, *b b*, therefrom to each light.

Fig. 5.



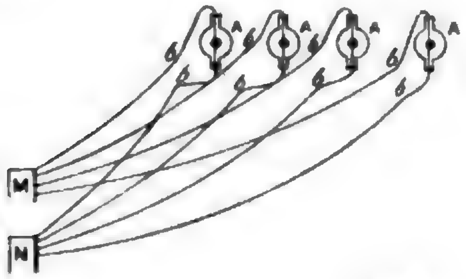


Fig. 6.

Fig. 6 is also an elevation, showing another method of connecting the lights with the machine, each light having a distinct wire, *b*, running to each pole of the machine, M and N.

Having thus described our invention, we claim: The placing of carbons, B, in lamps or other suitable vessels, A, filled with rarefied gas, possessing the property of not chemically combining with the carbon when in a state of incandescence, in connection with the arrangements of the electrodes, E E, fixing, or connecting the carbon, B, substantially as set forth.

Henry Woodward.
Mathew Evans.

Toronto, Ontario, 24th July, 1874.

Signed in presence of
James Foster.
William Gill.

This is the specification referred to in the affidavit of Henry Woodward and of Mathew Evans, hereto annexed. Sworn before me this 24th day of July, A.D. 1874.

James Foster, J.P.

THE ELECTRIC LIGHTING OF SYDNEY.

The special sub-committee of the Sydney City Council, appointed in February last to report upon the cost and advisableness of establishing a system of electric lighting for the city of Sydney, and of which the Mayor (Alderman W. P. Manning) was chairman, has concluded its labours under the resolution of the Council. Its report was presented to the Committee of Finance of the above Council on the 1st October, and unanimously agreed to. The sub-committee declare it is advisable that a system of electric lighting should be introduced, and they recommend for consideration the scheme elaborated by Mr. Cracknell and Prof. Threlfall, who all through have acted as advisers. This scheme provides for three stations, where the necessary plant and machinery can be erected, with sufficient space for the storage of coal and stores. The positions considered most suitable are all the property of the Corporation, and are as follows: 1. Kent-street, with a frontage to Darling Harbour. 2. Woolloomooloo, used by the Corporation for a metal depôt. 3. Corner of Prince Alfred Park, at the junction of Castlereagh-street and Devonshire-street. The advantages of these positions are, it is said, that each is the centre of almost separate districts, and is well situated for a cheap delivery of coal It is proposed to light the streets by a combined system of arc and incandescent lamps; arc lamps for the principal streets, on poles 35ft. to 40ft. high, at a distance of four chains apart, alternately on opposite sides of the streets, the mains of the arc lamps being laid underground. The less important thoroughfares may be lighted by means of 25-c.p. incandescent lamps with overhead mains. The number of lamps employed is 431 arc and 1,443 incandescent. The arc lamps will be arranged in about 11 circuits of 40 in series, and the circuit will be so arranged that lamps on opposite sides of a street will be on different circuits, so that in the possible event of a breakdown of one of the circuits, no street will be left in total darkness. The incandescent circuits will be run in a different manner; the incandescent lamps will be run in multiple series of 40 lamps in each circuit. The total cost of the installation of the street lighting system is estimated at £105,696, and the total annual cost of maintenance at £15,833, or a little over £24 per annum for each arc light of 2,000 c.p., and £3. 12s. for each incandescent lamp of 25 c.p. It is proposed that half the arc lamps be extinguished at 12 o'clock, the remainder being worked all night. The lamps can be extinguished from the central stations. The private lighting is met with a provision for plant equivalent to the continuous supply of 10,000 16-c.p. lamps. The number of lamps which may be safely installed, the report states, will be considerably more than this, as it has been found in practice that the maximum number in use at any time lies somewhere between one-half and three-fourths of the number of lamps installed—*i.e.*, with the above plant the capacity of the stations would be from 14,000 to 16,000 16-c.p. lamps. The total cost of installation, including mains, etc., is estimated at £60,737. The total annual cost of running with all lamps taken up, is estimated at £9,315; the probable revenue, charging 8d. per Board of Trade unit, would be about £14,400; with 10,000 lamps wired, the annual expenditure would be £8,631; and the income, charging 8d. per Board of Trade unit, about £9,000. With 5,000 lamps taken up the expenditure is estimated at £7,585, and the income, charging 8d. per Board of Trade unit (the usual London price), would be about £4,500. It is proposed to divide the private lighting amongst the three stations, consumers in the vicinity of Kent-street station being supplied by means of the direct low-tension system, and those beyond this area being supplied by means of high-tension alternating currents and transformers. The average number of lights of about 16 c.p. used in dwelling-houses is about 20; this allows for lighting about 700 dwelling-houses. It is probable that many hotels, warehouses, banks, etc., would take the light, using from 100 to 500 lights each. In any case, it is considered this estimate makes provisions for all private lighting likely to be required for some years. The street area which it is proposed to light by electricity is at present lit by means of about 3,000 gas lamps of about 12 c.p. each, aggregating about 36,000 c.p. in all, at an annual cost of maintenance for gas of about £12,500. In the scheme proposed these will be replaced by 431 arc lamps of 2,000 nominal candle-power each, and 1,443 incandescent lamps of 25 nominal c.p. each, aggregating in all 899,000 nominal c.p., at an annual cost of about £16,000. This means nearly twelve times as much light, with an increase of cost of maintenance of less than 22 per cent.

In moving the adoption of the report, Alderman **Martin** said he regretted that they were now only just entering upon a matter of such great importance. Still, the report which had been presented had come at an opportune time. Only recently they had had a field-night in Parliament, when a gentleman had introduced a Bill which in effect asked that a monopoly should be given to a private company to supply the city of Sydney and its suburbs with electric light. He wished to conserve the interests of the citizens, and when the Bill was introduced he had striven to speak with that end in view. He had found it difficult to convince the House that the City Council was in earnest in its desire to carry out a system of electric lighting, and a number of unfair remarks had been made on the subject. They had advanced the old argument in favour of a monopoly being given to a private company, and were oblivious to the fact that were this granted, the streets of the city would be torn up by rival companies, which would tend to injury to the citizens and the impeding of the general traffic. He had no doubt that Parliament would oppose granting the privilege to any monopoly if they knew the City Council intended to take the matter up. In the report before them every care had been taken to conserve the rights of the citizens at all costs. After traversing the question of the right of the council to supply electric light to private individuals, the speaker said that at present the annual cost of lighting was £12,500 for light equal to 36,000 c.p. Under the new system proposed the citizens would be supplied with light equal to 899,000 c.p. at an increased cost of merely £3,000. The proposals, however, with regard to the supply of electric light to private houses would, if carried out, change the debit of £3,000 into a credit of £5,000.

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* This being unimportant we omit.

Alderman RILEY seconded the resolution. He wished to draw attention to the fact that the Council had merely endeavoured to get at the root of the matter, and not to give themselves into the hands of mere experimentalists, and thereby waste the citizens' money. The proposal they brought forward meant 12½ times more light than they had at present, and at a rate of 22 per cent. more than what they were then paying.

Alderman M. CHAPMAN agreed in the main with the report of the committee, but was opposed to the idea of the Municipal Council supplying private citizens with light.

Alderman MARTIN moved, "That the committee be instructed to obtain specifications on which tenders could be called for in order to save time whilst the Bill was being drafted."

Alderman CHAPMAN thought that such a motion was premature. They must get power from Parliament first.

Alderman J. HARRIS said that the object of the Council was to get all they could, in order to obtain power to light the city of Sydney by electricity, and then lease out to private companies, as the Council saw fit, the right to afford light to private houses. The Council could do the work more effectively, and cheaper, than any private company, inasmuch as they wanted no profit, but merely to benefit the citizens.

After some further discussion the proposition of Alderman Martin was withdrawn on the understanding that the committee should continue their labours.

It was then agreed, on the motion of Alderman MARTIN, seconded by Alderman M. CHAPMAN, "That the city solicitor be instructed to draw up a Bill on the lines of the report furnished, to give the City Council power to arrange either for the supply of electric lighting at their own cost, or in part to grant concessions to other companies."

ELECTRO-HARMONIC SOCIETY.

The next concert of this society will be a ladies' night, and will be held in the Banquet-room of the St. James's Hall Restaurant, Regent-street, W., on Friday, November 27, 1891, at eight o'clock. Artistes: Miss Florence Bethell, Miss Mary Hay, Mr. Braxton Smith; solo violin, Mr. T. E. Gatehouse; solo violoncello, Mr. W. C. Hann; solo pianist, Mr. Alfred E. Izard; humorous sketch, Mr. G. Pritchard. Musical directors: Mr. T. E. Gatehouse and Mr. Alfred Izard. A Broadwood piano will be used.

PROGRAMME.—PART I.

Instrumental trio .... "Molto Allegro" .... Mendelssohn.
(from Trio Op., 49.)
Messrs. T. E. Gatehouse, W. C. Hann, and Alfred Izard.
German songs ... { (a) "Ich Liebe Dich" / (b) "Wald wanderung" } .... Grige.
Miss Mary Hay.
New song ... . "For all eternity" .... Maschoroni.
Miss Florence Bethell.
"Violin Obligato," Mr. T. E. Gatehouse.
Violoncello solo ... . "Souvenir de Spa" .... Servais.
Mr. W. C. Hann.
Songs ....Two "Gipsy songs" .. .. Dvorak.
Mr. Braxton Smith.
Humorous sketch ....
Mr. George Pritchard.

PART II.

Duet .... "O that we two were maying" .... Gounod.
Miss Florence Bethell and Miss Mary Hay.
Song .... "The anchor's weighed" .... Braham.
Mr. Braxton Smith
Violin solo .. .. "Scotch Melodies" ... .
Mr. T. E. Gatehouse.
Song .. .. "O! loving heart" .... Gottschalk.
Miss Florence Bethell.
Pianoforte solo .... "La Campanella" .... Liszt.
Mr. Alfred Izard.
New song .... "By the river" .... Wadham.
Miss Mary Hay.
Instrumental trio ... "Andante and Finale" .... Mendelssohn.
(from Trio Op., 49.)
Messrs. T. E. Gatehouse, W. C. Hann, and Alfred Izard.

LONDON COUNTY COUNCIL.

ST. PANCRAS ELECTRIC LIGHTING LOAN.

At the meeting of the Council on Tuesday the following report was submitted by the Finance Committee:

LOAN TO VESTRY OF ST. PANCRAS.

We have considered the application from the Vestry of St. Pancras for a loan of £60,000 for electric lighting works, repayable in 42 years. This loan is required towards defraying the cost of erecting a central station at the rear of Stanhope-street (upon a freehold site purchased by the Vestry) to provide accommodation for the necessary machinery for supplying the electric current, which consists of an engine-house, boiler house, battery-room, store and other offices, at a cost of £5,700, and a sub-station built in the large open space under the public roadway at the south end of High-street, Camden Town, at a cost of £500 The Vestry have entered into contracts for the supply of engines, dynamos, boilers, switchboards, and storage batteries. The culverts for mains, copper conductors, and meters will be supplied under a schedule of prices. The total cost (including the two stations above mentioned and £475. 14s., the balance of the cost of the site) is estimated at £62,999. 7s. 5d., in which, however, is included £5,000 for future extensions, and £1,150 for works at the south end of Tottenham Court-road. The solicitor points out legal objections to the present advance of the cost of the sub-station, the works at Tottenham Court-road, and extensions respectively, estimated at £500, £1,150, and £5,000. With regard to the period of years over which the loan should be spread, the Council is precluded from making advances to vestries for works other than street improvements and bridges, for more than 30 years, and as the engines, boilers, dynamos, batteries, etc., cannot be expected to last for above half that period, we are of opinion that the usual course should be adopted—viz., to limit the period of repayment to the assumed life of the respective works, although we consider that the works being expensive and unremunerative at the outset, the repayment may be deferred for a period of two years. Taking the total cost as the basis of the application for the loan, we recommend:

> That, subject to the Council hereafter giving its written consent under seal to the borrowing, and subject to all necessary consents and evidence being furnished to the satisfaction of the solicitor of the Council, the application of the Vestry of St. Pancras for a loan towards defraying the cost of carrying out certain electric lighting works in the parish, be granted to the extent of £56,300, on condition that the loan is taken up at once, interest being charged thereon at the rate of £3. 5s. per cent. per annum, payable quarterly, on the 31st January, 30th April, 31st July, and 31st October in each year, and the principal being repaid by equal annual instalments on each 31st October commencing 31st October, 1894, as to £32,400 within a period of 30 years, as to £20,800 within 15 years, as to £2,100 within eight years, and as to £400 within five years from the date of advance; that it be referred to the solicitor to take the necessary measures for completing the loan, and that the amount be advanced out of the consolidated loans fund.

Lord Lingen, the chairman of the committee, asked leave to take the report back.

Mr. Eccleston Gibb said this was a matter of very great importance to the parish of St. Pancras. The policy indicated in the report of not lending them the money for 42 years would have the effect of destroying their work. He understood that the only point for reconsideration was whether that part should be withdrawn which proposed to give them two years before they started paying. That would only make the proposition worse than at present. If it was impossible for the Council to lend the money to the Vestry on the terms asked, it would be necessary to go to Parliament for power to borrow, and Friday was the last day on which notice could be given. If the Council did not do what the Vestry wished, or something very near it, there would be an end of the work so far as St. Pancras was concerned. It would mean either that the cost of electricity would be greatly increased to the consumer, or that the balance would be put on the ratepayers who were not consumers.

Lord Lingen replied that he should be exceedingly sorry if the parish of St. Pancras was inconvenienced, but the report required further consideration, and he thought he should not be doing his duty to the Council if, under those circumstances, he did not ask that it should be referred back to the committee. The Finance Committee would meet next day, and they might get over the difficulty of giving the parliamentary notices on Friday.

Mr. Wetenhall said that the demand for the electric light in St. Pancras was greater than the supply, and if anything was put in their way by which the works were frustrated or hindered, the result would be very serious indeed. He hoped that everything would be done by the Council to assist so great a work. St. Pancras had taken the initiative in the matter, and other parishes would be very likely to follow their example.

Mr. N. Robinson maintained that everything was going on as well as it possibly could, and he had the pleasure to announce that more than half of their output was already applied for.

Mr. Westacott said they had had complaints in the Council of the monopoly of gas and water companies, and the trouble of buying them up. St. Pancras had decided to prevent a monopoly in the matter of electricity, by doing the work themselves, and he considered that they ought to be encouraged. He suggested that they might insert a clause in their General Powers Bill of next session giving them the power to make loans to vestries for more than 30 years for works other than street improvements and bridges, if there was any difficulty at the present time. What they were lending on was not the electric light works, but the rates of the parish, which would be the security for the repayment of the money to the Council.

After some further discussion the report was referred back to the committee.

COMPANIES' MEETINGS.

WOODHOUSE AND RAWSON UNITED, LIMITED.

The general meeting of the shareholders in this Company was held at the Cannon-street Hotel on Friday, 13th inst., Sir Rawson W. Rawson, K.C.M.G. (chairman), presiding. There was a good attendance.

The **Secretary** having read the notice convening the meeting,

The **Chairman** said: Gentlemen, I have much pleasure in rising to render to you, our shareholders, an account of our stewardship during the past year, the second of our existence. Considering the extraordinary financial crisis that occurred during that year, and the general commercial depression which ensued, we trust that you will find the results of the operations during that period eminently satisfactory. Taking the balance-sheet and looking to the profit and loss account, you will find the following results. Deducting from both sides of the account the amount of £16,000 brought forward from the previous year, you will find that the total earnings of the Company amounted to £89,000. Out of that we have provided for all our current expenses. We have provided for writing off what we consider a sufficient amount in reduction of the value of our patents. We have paid the interest due upon our debentures, and we have written off £10,500 of extraordinary expenses, some of which might fairly have been distributed over a further length of years; and then we leave a balance of £35,000 to meet our dividends. The dividend which we promise, and which this year we were certainly pledged to, of 15 per cent. on our ordinary shares, and 8 per cent. on our preference shares, that dividend amounts, as you see by the account, to £30,500. Secondly, having made a clear net profit of £35,000, we have a surplus of £4,500 applicable to such purposes as the shareholders, agreeing with the Directors, as we hope they will, may think fit. If we add to that the £10,000 of extraordinary expenditure, our earnings during the year were £15,000 above our current expenses, and that without trenching upon the £16,000 carried forward from the previous year. Now, gentlemen, the Directors hold, and we trust that you will hold, that in such an extraordinary year as that through which we have passed we have done well; a year, remember, peculiarly affecting this Company, because one of the branches of its business is to avail itself of new inventions, to utilise all patents which it possesses, and to interest the public in new inventions connected chiefly with electricity. This has been a year in which the public have not been disposed to enter upon new undertakings, and consequently we have had very little encouragement. We have had a number of proposals of different kinds which we have not thought it right to accept or make a move in, and yet in spite of all this we have made, as I shall show you, a clear profit of £35,000. I hope you will think that very satisfactory. Now, perhaps, the most useful course that I can adopt is to run through the balance-sheet and the profit and loss account, and to explain any matters that may appear to require explanation, or upon which you may seek for explanation. With regard to the debit side in the first column of the balance-sheet there is not much to be said. The points are these. We have reduced the mortgages upon freehold property by £3,000. Sundry creditors stands at £8,000 less. We have swept away the whole guarantee fund, which stood in the last account at £75,000. We have refunded that amount to Woodhouse and Rawson, the old company, and therefore that disappears from our balance-sheet, and you find inserted here for the first time a reserve fund of £25,000 and a pension fund for our employés of £1,065. Coming to the credit side there is an increase under freehold premises of £12,000, which is caused by the building and improved engine power erected at Cadby Hall, of which an account is given in the report, and also improvements in the Kidsgrove property, which was taken over this year and necessitated a certain outlay. I need not say much with regard to the next item, which refers merely to leasehold premises. As to the next three items, which are heavy ones—plant, stock, and expenditure on contracts—there is a large increase, but an explanation of it is very simple. We really commenced our work last year. The United Company having acquired new works, having made a new organisation, having extended its business I may say throughout the world, in Australia, South Africa, and other parts, necessarily had to make a large outlay on works for plant, on supply stations for stock, on installations and contract work for the work in progress. In fact, what did we ask money for but to extend our business? We have extended it, and the explanation of the increase in these items is simply that we have extended our operations, legitimate operations, connected with our trading and manufacturing; and it is an evidence of the increase of our business. The next item is the moiety of special expenditure on advertising repayable by instalments. You will understand that at the commencement of our operations it was advisable to advertise largely. It was a necessity because we were extending our business, and had to inform the public largely of the nature and extent of the business, working and trading business, which we were prepared to undertake. Then, again, a very important matter is that we have prepared, and are on the point of publishing, certainly the best, the most complete, and the most extensive catalogue of electrical and engineering apparatus and supplies connected with electricity of any firm in the world. This I believe I may safely say. At all events, we are rather proud of our bantling, and we assert that it is the best volume of the kind, calculated very much to improve the standing and credit of the Company, and extend our business throughout the world. The consequence has been that in its first issue there has been an excessive amount—not an improper amount, but a very large and heavy one—incurred for advertising and printing, and we have thought it right to divide the whole of the expense of this over the past year—not to spread it over three or four years. The result of the work is prospective: the expense is immediate. But we think it better to meet, as far as possible, all our expenditure as it happens; and as our earnings are sufficient to cover them, we have charged in this instance half to the last year's operations, and we intend to charge the other half to the present year's. The next item is patents and patent rights, in which there is an apparent increase of £10,000. This has not arisen from any material addition to the patents that we possess, but to the completion of the original purchase of two Woodhouse and Rawson subsidiary companies; and the completion of the purchase, which was delayed for a while for good reasons, was effected last year, and, of course, we take over their patents and their business, and so forth. According to the usual arrangements, that is also placed to the item of goodwill. It is not that we have enhanced or added to the value of our goodwill, except by the addition of the completion of the original contract for this purchase. The next item is sundry investments. If you compare the first balance-sheet with this, you will find in the first only £11,000 under the head of sundry investments. But you must take into account that below that there is the sum of £75,000, which was reserved to repay Woodhouse and Rawson, Limited; so that our investments in the first year were £87,000, and that figures now as £119,000. I say that to show you what the investments consisted of, but it would be best in your interests not to go into details, and all that I can say is this, that the valuation of these investments has been taken at the lowest and most reasonable figure—that they are not speculative investments. They are investments of which you have perfect cognisance—viz., our arrangements for the purchase of the patents and the profits of the companies that have been established—and therefore all I can say to you is that last year the investments which stood upon our balance-sheet were parted with at a price above that at which they stood in our sheet last year. And we have a reasonable hope that by not throwing these investments upon the market in an unreasonable manner—which any gentleman here who does business knows would be attended by injurious consequences to ourselves—we shall dispose of these next year on equally advantageous terms as we did before). The Managing Director says that we have already disposed of some of these, and everyone of them above the price in the balance-sheet). The item of sundry debtors has increased. Of course it increases. Thirty thousand pounds of it is guaranteed--that is, the whole of the increase is guaranteed. Naturally, as our business extends our debtors extend. I have now, I think, explained the balance-sheet, and I would come to the profit and loss account. As to the first item of salaries, my relation, the very able Managing Director, is a sufferer there, for the salaries of last year were very largely increased by his remuneration, which, as you know, depends upon the surplus of profits of the year. The consequence is that this year, the surplus being very small, his remuneration is very small. That explains the decrease under the head of salaries. The next item that calls for any explanation is the advertising and exhibition expenses, which I have already explained. Then, of course, there is a large increase under the head of debenture interest to repay the debentures issued during last year. With regard to the writing off of patents we have applied £4,156 to that purpose upon this principle: That we considered that if we wrote off $\frac{1}{14}$th—the life of a patent being 14 years; the foreign patents are not limited to 14 years, but the English ones are—taking, therefore, the life of a patent as 14 years, if we deducted each year $\frac{1}{14}$th they would gradually be written off and disappear. Last year we applied £7,400 to that purpose. This year we have not applied so much, but we make up $\frac{2}{14}$ths in the two years; so that we have written off £11,500 from our patents, and we shall go on writing off at the same rate—viz., $\frac{1}{14}$th every year. If it is objected that these patents which we possess do not all have a remaining duration of 14 years, the answer is this: For some of our patents we have paid nothing, and they don't stand in our books as possessing any value, and yet some of them possess large value. With regard to another class of our patents, the only charge that we create for new ones is the charge of registering, and therefore, taking these circumstances, and placing them against the fact of all our patents not having a life of 14 years, we consider, and I hope that you will consider, that to deduct every year $\frac{1}{14}$th from our patents is a reasonable calculation, and will bring us at the end of these 14 years to a blank as a claim against the Company. The next item is income tax for 1890 and 1891. Of course the tax for 1891 is a legitimate charge; the amount for the other year is an arrear. It might have been introduced in the accounts for that year (1890), but we did not know the amount. There was a dispute between the officers of the Company and the Inland Revenue Office, which was not settled till this year, and so two years' income tax are charged in this balance-sheet. The mortgage debentures redemption account is the sum paid to holders of 6 per cent. debentures for their redemption and the acceptance of debentures at 5½ per cent., and this account will only grow in proportion as our shareholders express their readiness to change their debentures according to our obligation, and I will say according to our wish, and therefore according to the real interests of the Company. The next item consists of preliminary expenses. The explanation of that is that the expenses actually paid, the preliminary expenses connected with the formation of the Company and the various charges in connection which it is impossible to explain in detail, were not paid in the first year. The sum that was actually paid was so small that it was brought into the general charge, but this year it has been considered proper to wipe off the whole charge, and it figures in this account. If it had been entered in last year's account it would have diminished the profit of that year and increased the profit of this year. The £2,000 for "Cadby Hall removal" is part of the estimated cost of the removal of our business from the one block in which it existed before we leased it, into the new block. It is partly cost of removal and partly the loss occasioned by the shifting of machinery, the impossibility of carrying on and undertaking new work whilst on the point of removing to a new building, which the manager estimates altogether at least £2,000. All these we consider are a proper charge against the annual earnings instead of distributing them, as we might have done over a wider range of time. This is all of importance on this side of the account. On the other side we find of course, that the gross profit is not as large as it was last year, but it is impossible to be blind to the fact of the very different state of circumstances last year to that preceding it, and the opportunities possessed by the Company of making profits. The balance of interest on loans and investments is £3,000 more, and there is also an item of rent derived from our West Kensington leasehold. The profit from premium earned on shares and transfer fees remained stationary. We propose to deal with the net profit, £51,439, as follows: we have already paid an interim dividend of £14,464; we propose to carry £10,000 to reserve; we have an item of bad debts reserve, which appears necessary, of £1,500, and we carry over £8,931 to next year's account. I trust that you will find that that is a very satisfactory explanation of our work during the year, and that you will adopt, accept, and approve of this balance-sheet and the report which accompanies it. The Managing Director, prompted, I believe, by one of my excellent colleagues, points out that it brings up our reserve to £45,000, which is more than enough to secure us for next year. [In answer to an interruption from a **Shareholder**, who said the total reserve was only £35,000, a director. **Mr. Pope**, pointed out that the £45,000 was made up of £25,000, the amount of the reserve on July 31, 1891, the £10,000 placed to reserve in the present profit and loss account, and the £9,000 carried forward—actually £8,931.] Resuming, the **Chairman** said: I shall not detain you long, but there are two or three matters connected with the report to which I should like to call your attention. Before doing this, however, there is one point, an important one, in which I personally feel a great interest and desire personally to speak about—that is, the refusal of our quotation. Lord Aberdare promised it as far as he could; I did the same, and in an important communication to the shareholders I have stated my belief—I have given them to understand that as far as I knew there was nothing to prevent our having it. I have full justification for this belief. Our papers, after sundry references and considerable delays required by the Stock Exchange, were pronounced to be in order. We had every reason to suppose that we should receive our quotation, and that the only cause of delay was the finance committee of the Stock Exchange; that the papers were voluminous and required some considerable time on their part to examine and understand them before granting a quotation. Three weeks before the quotation was refused we had the most reasonable expectations from parties of the highest position in the Stock Exchange that the quotation would be granted. The refusal took us as an entire surprise. We have not the least idea—I won't say the least idea—we have not the least knowledge of the cause of the rejection. The committee of the Stock Exchange is autocratic, and does not give its reasons. The only surmise that we can form is this: that until the old Woodhouse and Rawson, Limited, Companies are wound up, the Stock Exchange will not give us a quotation. They have granted a day of settlement, but not a quotation. We are given to understand that after a reasonable delay, if we apply again, we may get it. I hope you will allow us to use our discretion as to the proper time to apply for it. My own impression is that we should not apply until these companies are wound up, and we stand upon our own legs. As we mentioned on a previous occasion, there are difficulties in the way of winding up all the companies. I have acquired an experience which will make me very cautious of holding out promises which depend upon other men's actions. Turning to the report, I am able to speak of the very great improvement that has been made at the West Kensington works by the erection of the new block of buildings and of the new engine-house. It will enable us to undertake a class of business which is likely to prove highly profitable. We can undertake not only to carry out the great source of our credit and of our profit—the manufacture of specialities—but we can give to the public an apparatus of value and of importance. Hitherto we have been confined very much to that class of business—viz., electrical specialities—but this new block will enable us to undertake on a larger scale the manufacture of mechanical apparatus as well. For instance, typewriters and articles of that kind requiring great delicacy in construction. We have at present a whole floor of that building—and a very extensive one, too—available for turning out many thousands of machines. We have another contract which we hope to commence work upon in a few weeks of a similar character. We look therefore to a considerable extension both of business and profit in that block. With regard to Kidsgrove foundry, you must remember that we only entered into business at the commencement of last year. It was a business that required considerable improvements in many ways, and we had to carry out at a disadvantage in many respects the work begun by the previous owner of the foundry. All that has passed away, and in the coming year we expect very different results from the Union Foundry at Kidsgrove. One of our objects in acquiring these works—it must not be supposed that the Directors have plunged into the acquisition of works simply to make a new business—was this: We possessed a means of making all electrical apparatus of a small character—switches, and a variety of things of that kind; but we had no works in which we could on a large scale make or manufacture dynamos and engines and introduce new inventions—specialities, as I call them—such as are noticed in the report, Gallwey's hydraulic machines (which are of great promise), Mr. Bolton's electric cranes, and so on. We hope before we meet you again that we shall be able to report that we have established a sound and profitable business there. I may pass over the Cornbrook Telegraph Works. With regard to the supply department, that is going on very satisfactorily. During the year of which I am now treating there was necessarily a large expenditure in that department to bring our stock up to the required amount. We have to maintain a large variety of different articles which are required by our various customers in all parts of the world. Such a large expenditure will not I believe be necessary in future. We have obtained a degree of completeness in that department which will not necessitate any large future expenditure. With regard to the installation department we have every reason to be satisfied with the result, its business is largely increasing, and I am glad to say that the character of our work is such as to bring credit to us and secure the confidence of our customers. A very important matter is that with reference to the Epstein accumulator. I hope you will consider that it is a proof of the discretion of the Board that out of the four inventions which we had under examination and test, we have finally accepted only one. We are not plunging into the purchase of inventions which we are not satisfied will bring us profit. As to the Epstein accumulator we have had it under observation and test for two years, and the result is as satisfactory as we or you could possibly wish. We did not enter into that application until we were satisfied that it was the most efficient accumulator, that it opened up a new field for traction purposes, and that in efficiency and economy it was superior to anything that existed, and also until we were perfectly secure as to our patents. We have had the authority of four or five of the most eminent patent agents and leading counsel before we entered into any arrangements with Epstein, and we have a most valuable property in this battery. We are carrying on the manufacture of it in our own buildings, yielding us not only rent but profit. As I said before, I don't like promising, but I can conscientiously say that the report and balance-sheet give you an unexaggerated and fair statement of what we have done, and I may say that I have every reason to expect that our next year will be at least as good as the last, or even better. We have every reason to think so. Such being the case, I hope you will be satisfied with what the Board has done, and will testify it by the acceptance of the report and balance-sheet. I shall be very happy to answer any questions any shareholder desires to put to the best of my ability, and beg to move that the report and accounts be adopted.

Mr. Philip Rawson seconded this.

Mr. Dixon had one or two questions to ask as to the patents. He thought the allowance for depreciation of patents was small. True, the foreign patents had more than 14 years to run, but was it not a fact that they must be taken out in England before they could be of any use there, and therefore their life was no more than that of an English patent. Was it not a fact, also, that nearly every patent that was taken out did not run 14 years before it was superseded by new inventions? Surely in electrical matters new inventions were continually going on, so that the life of a patent did not extend to 14 years. If this was so, would they not at the end of some 10 years find themselves with a large item in the accounts which really represented nothing at all but worn-out patents—not expired by effluxion of time, but superseded. This should be taken into account, and the allowance should be more than 7 per cent. Further, many of these patents had not 14 years to run. The Secretary had told him so. The average was about 11 years. At 7 per cent. that would only make 77 per cent. written off, and so it was not sufficient. As to goodwill, which he stigmatised as a dead weight, no one, he said, reckoned goodwill as part of his assets. If he were a prudent man he would save a part of his profits until he had recouped his capital outlay, and that was what he asked that they should do. Then there was no information as to what their investments consisted of. There should be reasons for this. These were matters which were blots on the face of the account, and until they were removed he for one would not be disposed to pass it. They wanted an account upon which they could rely, which they could show to themselves and the world, which stated exactly what it was, in which there were no speculative matters, and where proper allowance was made to clear off the dead weight of goodwill which rested on them. He would therefore propose that the meeting be adjourned for a fortnight to give the Directors an opportunity of reviewing the matter.

This was seconded by **Mr. Burberry**.

Mr. Griffiths noticed that in the auditor's certificate it was certified that the "amounts taken credit for, for plant, stock, and works in progress, and investments not quoted, have been certified by the Company's officials." He thought it would be more satisfactory if this certificate were set out *seriatim*, and that the gentleman who certified as to plant should take the responsibility of putting his name to the certificate, and so on with the stock and investments,.which were very speculative; in order that in time to come they might know upon what gentleman they had to rely for the estimates formed upon these important points—plant, stock, works in progress, and investments. At present they had before them merely a book audit, which did not enable them to come to a satisfactory conclusion upon the questions involved, and they had not the names of the persons who were responsible for the certificates given. Looking at the items of the account, he must say that he agreed with the first speaker. Patents might be very valuable one moment, and almost immediately be superseded. But this point might perhaps be left to the skill and science of the gentlemen on the Board. They were undoubtedly men of great weight in the electrical world, and although their views of figures were not satisfactory, they must give them credit for being good electricians. He thought it was a serious thing that they had the goodwill set down at £98,000 when they knew nothing at all about it. Perhaps it was the price paid, but that ought to be set out in detail. And when they added to goodwill the further item for investments, they had a large amount which made them somewhat anxious. He would suggest that it would be wise not to extend their business by buying new companies and starting departments in different parts of the world. When they had been in existence for some time, when they had a reserve fund, then by all means use it for extending their business. But while the reserve fund was small, it did seem speculative to extend such a business as theirs. Any extension necessarily produced an increase of expenditure, but whether that extension would produce a profit was a problem—the expense was sure, the profit uncertain. These were not mere haphazard remarks. The Chairman told them that the gross profit that year was less than the gross profit last year. Less! when they had paid a great deal in extending their business, their capital expenditure had been great, the expenses of management had increased, and yet the gross profit was less. He thought that this supported the argument that he advanced—viz., that at present it was not wise to extend their business too much when their profits were falling off and their expenses were increasing.

Mr. Peake, referring to the remarks of Mr. Dixon as to the investments, said that at the meeting of a company with which he was connected the same question was asked, and the answer of the Chairman was that he would give directions to the Secretary to allow any shareholder to investigate any book in the possession of the Company, but that he did not think it wise to publish to the world what their investments were. At the same time he thought it reasonable that any shareholder who liked should know what those investments were. He (the speaker) thought this was reasonable, and that it would give shareholders greater confidence if they knew what the Company's investments were. It seemed to him that nobody would go into such a Company as that unless he was ready to a certain extent to speculate. He did not mean Stock Exchange speculation, but the ordinary speculation which existed of necessity in any commercial enterprise of that nature, and must be eminently associated with a Company of that kind, which had an entirely new business hardly dreamt of 10 or 15 years ago. He thought it would be better if the Directors took the shareholders a little more into their confidence. He quite agreed with the remarks of Mr. Griffiths so far as the figures were concerned. The gross profits were less and had been earned on an increased capital. As to inventions, if they were to go in with the business they must take inventions and try them. The only thing the shareholders could do was to impress upon the Directors that they should do their best for them and there leave it. He thought shareholders should be allowed to see what those investments were, and to have any other information with regard to the Company; it belonged to them, why should not they have this information?

Mr. Bacon said that when he first saw the prospectus of that Company which was formed to manufacture and dispose of articles connected with engineering and electricity, he felt that there was a great field for profitable investment, and though this might be called to a certain extent speculative, yet it was only speculative upon what he believed to be solid ground, and therefore he became a shareholder in the Company. Now any remarks made on that side of the table were naturally received with something like a disagreeable feeling on the part of Directors. They were not very fond of independent shareholders getting up and making any remarks at all. But seeing that they did make remarks, they felt that these remarks must of necessity be antagonistic. In this instance he did not wish to assume such a position. He had no idea of making any remark which should disparage that valuable business. Nor did he wish that shareholders should refuse to pass the accounts at that time. He perfectly agreed with what had been said respecting the patents. He thought it would have been wiser for the Directors to have written off at least as much as they did last year; and as far as the goodwill was concerned, he thought it rather a monstrous thing on the part of the Directors that they should not have applied the £10,000 to the reduction of the goodwill. Now they had massed this sum in with the reserve account, and it had been stated by the Chairman that there would be £45,000 to the good to be distributed in future years to the shareholders if necessary. Now £10,000 of that, it seemed to him, should have been put into a separate reserve fund for goodwill, because that was the way the £10,000 was dealt with this time last year. But, as regard these matters, he did not think they called for anything so serious as to refuse to pass the accounts, and to ask for the figures to be altered. What he would call attention more particularly to was the locking up of their immense capital. He was in business for 40 years, and therefore he knew something about it; and he knew the unwisdom of locking up assets in such a form as had been done in this instance. He did not want to say this invidiously or improperly. He dare say the Directors expected to have had more cash in hand. But what they had done was to lock up £93,000 in stock—a large increase over last year. Now, he argued that for a manufacturing concern to do this was the height of folly. There was £93,000 locked up in things which when they came to find that they were gradually being superseded by something better and fresher, it seemed unwise to put such a lot of money in stock. He saw also that the book debts had largely increased. It was right and proper that they should have done so, but not to the extent they had. It looked to him as if the Directors were rather financing a large number of their customers. Then the locking up of £119,000 in quasi-investments—investments which they were ashamed of showing to their shareholders—he had no doubt they would be all right, and that some of them had been realised at a profit, but still that was a matter of speculation to a certain extent. Probably these investments were investments in certain companies they had helped to float. He was connected with a number of companies which did actually publish their investments regularly. Many of them were insurance companies, and telegraph companies, and so on. However, he would not press this matter. He did not think it was to the advantage of the shareholders—evidently it was not—that the details should be known. He only wished to express a caution. Those gentlemen (the Directors) were transacting their (the shareholders') business, and they were locking up their capital in a way in which they could not realise it, and they would not be able in years to come to continue to pay a dividend if they did not turn over a new leaf. He thought they ought to pass the accounts, but still for the future if the Directors would take a more reasonable ground of action, if they would work more carefully, and not speculatively, realise stock and not accumulate, then it would be better. He spoke thus as a man of business.

A **Shareholder** asked whether the Board were adding to the patents held by the Company from time to time, at almost a nominal figure, those taken out by their workmen and others. If this was so then it seemed to him rather a question of form than a precise matter in how many years they wiped off their patents, because they were taking no credit for new ones. In the future they would have reduced the amount to nothing, and they would have their patents to the good, without charging any more for them. Could the Chairman tell shareholders whether there was a fair prospect of the subsidiary companies being wound up within the next year?

The **Chairman** called upon the Managing Director to answer questions as to patents, etc.

Mr. F. L. Rawson, in complying, said there were various foreign patents with a longer term to run than 14 years; but a previous speaker was quite right: if they wanted to have the benefit of them they must take them out in England. As to new patents it was, as another speaker had said—viz., they had a large number continually being taken out by their staff, and these were put into the balance-sheet at the cost of registration, which was £14, so that the patents really became more valuable as time went on, and got wiped out by writing off $\frac{1}{14}$th every year. He hoped to clear them off altogether in time. To show that some of these patents were of value, he would mention that they had a tentative offer of £10,000 for one which had recently been taken out. Last year, and this applied also to the goodwill, the Directors could not tell what the value of the patents was, and, therefore, a larger amount was written off. Now they had two years' experience, and, therefore, they could write off a regularly determined amount—viz., $\frac{1}{14}$th. It was the same with goodwill: although the dividends paid by that Company had been for five years, 12 per cent., 12 per cent. and 15 per cent., and so on, the value of goodwill could not well be ascertained. His own belief was that it would not show any profit, and, therefore, he thought it very wise to put a large amount to special goodwill reserve. The value of the goodwill had now been proved, because in a period when it was most difficult for them to make large profits they had been able to show that they could make profits sufficient to pay 15 per cent. His own advice would be to write off goodwill altogether from the account. As to the audit, the Auditors were particular to have every single thing certified, and to have the actual certificate from the person who was responsible. His instructions to the Auditors were to cut down everything as low as possible, and, as a fact, complaint was made by the works manager of the way in which they cut down his prices. As to the extension of the business, of course they could not expect a business to commence to pay the very first year. They had special powers in their articles whereby the cost of that new business could be extended over a series of years. They had not done this, but they had written off every penny of new business expenditure to revenue account. As to the questions with regard to investments, one of the speakers had called on him at the office on the previous day, and he (the speaker) showed him a list of the investments, and went right through them with him. The Directors stated that they would be very glad if Mr. Peake would call upon him, and he would show him everything. (**Mr. Peake** interrupting: And any other shareholders?) No, Mr. Peake only; and the speaker pointed out that if everybody were to see the list, the market for the investments might be spoilt. This was dissented to in the body of the room, though others agreed with the Managing Director's views. Eventually it was agreed that the list should be seen by Mr. Dixon as well as Mr. Peake. Continuing, Mr. Rawson said as to locking their money up in stock; when he first saw the figures he said they would not do. In consequence, he went right through the items with the manager of their supply department, and tackled him three or four times as to whether he was perfectly certain he had no dead stock. In that department it was necessary to keep a very large stock, because people wanted to come in and be able to buy anything they might require. If shareholders would look at the catalogue they would see the extraordinary variety of articles they had to keep, and one of the reasons why the business was increasing was that people knew they could come to them and get what they wanted at once. He thought it was a good idea that they should make the heads of the departments responsible for the certificates as to stock. As to the progress of the business he would like to give his explanation of the policy he would endeavour to adopt. This was, as time went on, to gradually build up a business in what they called pure electrical work, that was manufacturing articles as well as supplying them. They must recollect that they were only on the eve of what he believed would be an immense extension of electrical work. To be in the van and to take a part in that, they must spend largely on all sorts of new things and keep themselves in front. Very few electrical companies like themselves were able to pay large dividends, but they were just commencing to do it. Private individuals had had a very bad time of it during the last five or six years. But owing to their knowledge in connection with patents and so on, the Company had been enabled to pay large dividends out of the profits of manufacture and supply work. Last year they spent money on a thing which they could have turned over at a profit, but they considered it was to the best interests and ultimate success of the Company not to do so. He thought that if they got a moderate amount of that work which was the best paying—viz., manufacturing and supply—it would not be very long before the industry would have increased to such an extent as to enable them not only to make the improvements suggested in their balance-sheet, but to do better things still.

The **Chairman** then put the amendment proposed by Mr. Dixon and seconded by Mr. Burberry—viz., "That the meeting be adjourned for a fortnight to enable the Directors to review their accounts." This was lost, only four voting in its favour. The resolution in favour of the adoption of the report and accounts was then put and carried, as also was a resolution in favour of the declaration of a dividend of 15 per cent. on the ordinary and 8 per cent. on the preference shares.

The retiring Directors, Mr. Philip Rawson and Mr. Samuel Pope, Q.C., were re-elected, and Messrs. Jackson, Pixley, Husey, and Co. were re-elected auditors.

A vote of thanks was accorded to the Chairman and Directors on the proposition of **Mr. Bacon**, and the proceedings closed.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.

The twenty-ninth ordinary general meeting of this Company was held on Tuesday at Winchester House, Mr. C. W. Earle presiding.

The **Chairman** said that the report dealt with a period which he feared had not been very prosperous to West Indian commerce; at any rate, it was not nearly so good as the June half of 1890 would appear to have been, judging from their traffics, and he did not think they could have a better barometer than this as to the commercial doings of countries like the West Indies, where there was no great Stock Exchange speculation, as there was in New York, and, fortunately, no revolutions as there had been in South America. Before the French cable commenced working at the beginning of June the decrease in the Company's earnings, compared with those of the previous year, amounted to 10 per cent., and he presumed that this was attributable to the bad sugar crop. The total decrease in their receipts for the half-year had been £4,710, but, as a set-off, there had been a saving of £1,800 in the expenses. The balance they had to deal with was £22,773, as compared with £25,681 in the corresponding period of the previous year. They had placed £2,000 to the reserve fund, and they proposed to pay the preference dividends and 1s. a share, tax free, on the ordinary shares. The decrease of £1,800 in the expenses was owing to the reduction in the cost of cable repairs, for they had only had seven interruptions to their cable in the half-year under review, compared with 12 in the corresponding period of 1890. They would doubtless regard as most important that part of the report which treated of the competition which had appeared in their system. After referring to the French cable, he said that they opened at a tariff of 2s. a word below this company's, and in order to prevent the diversion of their traffic and to put the British colonies on as favourable terms as the French, they themselves made proportionate reductions. The result had been what anyone acquainted with the effect of tariffs in countries like the West Indies would foresee—viz., a considerable decrease in their revenue. More than half of the decrease which they were now showing in their traffics was, however, attributable to there being fewer words in the messages, and therefore he hoped that the present might be regarded as a very exceptional position. They had, he said, proved by the experience of many years that there was not traffic enough in the West Indies to support one company properly, and the appearance of another could only be disastrous to the latter, costly to this Company, and, in the long run, disadvantageous to the public. Their competitors now had two cables broken down, and, as far as he knew, no means on the spot of repairing them, and he was inclined to think that the short experience they had gained had been somewhat discouraging. They were better prepared for the struggle than their adversaries. Their lines were duplicated, whereas their rivals were dependent upon single cables, and while they had their ships and their establishments for the storing of cable for repairs, the French company at present had none. They also had a fair reserve to meet possible contingencies, and, although they must suffer in their revenue while the contest lasted, they hoped that their losses—disappointing as they were, just as they had appeared to be entering into a more prosperous condition—would not continue to be so severe as the present traffic returns indicated. The return for the last fortnight, which had been received that day, was much more favourable. He was informed that the next year's crop of sugar promised well, and if that harvest were a good one they might return to at least the same volume of traffic as they carried last year. He would move the adoption of the report and the payment of the dividends recommended.

This was seconded by **Mr. William Ford**, and carried unanimously.

MORECAMBE ELECTRIC LIGHT AND POWER COMPANY.

The first statutory meeting of this Company was held on Monday last at Morecambe. Mr. G. R. Snowden presided. The **Secretary** read a statement of the Society's affairs, which was approved; and the Company's engineer produced a plan showing the position of the central station and the main cables to be laid for supply. The provisional Directors were unanimously re-elected, with power to add to their number. The appointment of Mr. J. Duff as auditor was confirmed.

COMPANIES' REPORTS.

BLACKPOOL ELECTRIC TRAMWAY COMPANY.

The annual report of this Company states that the available profits amount to £3,234. The Directors recommend a dividend of 7½ per cent., absorbing £1,500, and the addition of another £1,500 to the reserve fund, making it £6,000. The number of passengers carried during the year was 933,652. The total receipts were £7,200. Messrs. Horsfall, Bickerstaffe, and Broadbent are the retiring directors.

SWAN UNITED ELECTRIC LIGHT COMPANY.

Directors—J. S. Forbes, Esq., chairman; F. R. Leyland, Esq., deputy-chairman; E. W. Batt, Esq.; W. C. Quilter, Esq., M.P.; J. W. Swan, Esq.

Ninth annual report of the Directors, to be presented at the ordinary general meeting of the Company, to be held at Cannon-street Hotel, E.C., on Tuesday, 24th instant, at 12 noon.

The accounts which are herewith presented to the shareholders are for the year ending 30th September, 1891. After paying all current charges, and making due allowance for depreciation, there is a credit balance of £47,490. 11s. 2d. The Directors recommend that out of this balance a dividend of 11 per cent. for the year be declared; an interim dividend at the rate of 6 per cent. per annum, amounting to £11,104. 0s. 5d., has already been paid in respect to the first half of the year; the balance of the 11 per cent. for the entire year to be distributed in accordance with clause 77 of the articles of association, and to be payable on the 1st Dec. 1891. This will absorb £28,376. 6s. 11d., and leave £8,010. 3s. 10d. to be carried forward. The decision of the Supreme Court at Leipsic, in the patent cases which the Allgemeine Electricitäts Gesellschaft brought against the Company, and their agents, has been given in favour of the Company. The Directors are now engaged in the consideration of the best way to take advantage of the favourable position thus created in Germany. The Compagnie Générale des Lampes Incandescentes in Paris have been in litigation as to their patents throughout the year. The experts to whom the Court referred the case have not yet rendered their report to the judges, and until this is completed the Court cannot adjudicate on the case. The Compagnie Générale does a considerable amount of business, but competition is very keen on the Continent, and the selling price of the lamps is much reduced. The director who retires by rotation is Mr. J. W. Swan, who, being eligible, will offer himself for re-election. Messrs. Welton, Jones, and Co., the auditors, will also retire, and will offer themselves for re-election.

PROFIT AND LOSS ACCOUNT FOR YEAR ENDING SEPT. 30, 1891.

Dr.	£	s.	d.
Stock, October 1, 1890	11,124	14	0
Purchases	11,723	2	9
Salaries, Directors' fees, rent, office expenses, income tax, general and law charges	3,379	13	11
Wages and expenses at factory	5,107	13	1
Depreciation	392	12	3
Sales ledger reserve	300	0	0
Balance	39,038	13	4
	£71,066	9	4

Cr.	£	s.	d.
Sales, less commissions and allowances	15,348	11	10
Transfer fees and interest	1,290	2	3
Dividend on shares in La Compagnie Générale des Lampes Incandescentes, less tax	1,178	6	2
Dividends on shares in the Edison and Swan United Electric Light Company, Limited	34,799	11	6
Stock, September 30, 1891	18,449	17	7
	£71,066	9	4

BALANCE-SHEET, 30TH SEPTEMBER, 1891.

Dr.	£	s.	d.	£	s.	d.
To share capital:						
19,750 shares of £5 each fully paid	98,750	0	0			
78,949 shares of £5 each £3. 10s. paid	276,321	10	0			
				375,071	10	0
Forfeited shares				3,530	0	0
Sundry creditors				4,642	10	11
Balance from previous account	8,451	17	10			
Balance 30th Sept., 1891	39,038	13	4			
	47,490	11	2			
Less interim dividend at the rate of 6 per cent. per annum for six months ended 31st March, 1891, paid on May 21, 1891	11,104	0	5			
				36,386	10	9
				£419,630	11	8

Cr.				£	s.	d.
Cost of patent rights, etc., represented by shares in Edison and Swan United Electric Light Company, Limited, with £208,478 paid; shares in La Compagnie Générale des Lampes Incandescentes with £30,489. 8s. 3d. paid; patents held by the Company for Germany, etc., as per last balance-sheet	£330,837	2	5			
Additional expenditure thereon—subject to readjustment between the companies	1,612	1	0			
				332,449	3	5
Outlay on factories, plant, etc., as per last account	1,963	1	3			
Less depreciation	392	12	3			
				1,570	9	0
Sundry debtors				6,545	15	4
Stock on hand				18,449	17	7
Investment in Prussian Consols. Cost				5,120	0	0
Investment in new 2¾ per cent. consolidated stock. Cost				29,004	19	6
Cash on deposit and in hand				26,490	6	10
				£419,630	11	8

PROVISIONAL PATENTS, 1891.

NOVEMBER 9.

19339\. **Facilitating the operations of switching usually carried on in telephone exchanges by means of an improved switching apparatus.** Robert Ingram Howe Pippette, 31, Endymion-road, Brixton Hill, London.

19348\. **An attachment or means for electrical measuring, sale, and delivery, or delivery with measurement only.** Rowland William Brownhill, 6, Livery-street, Birmingham.

19370\. **A new or improved device for supporting shades or reflectors for incandescent electric lamps.** Ernest Dunand, of the firm of Louis Dernier and Co., 76, Chancery-lane, London.

NOVEMBER 10.

19390\. **Improvements in dynamo-electric machines and apparatus appertaining thereto.** Henry George Read, 92, East Ordsall-lane, Salford, Lancashire.

19398\. **Improvements in or relating to bases for electrical switches.** Albert Hoster, 51, Cannon-street, London.

19424\. **Improvements in electric globe and shade holders.** William Henry Parry and John Whitehead, 42, Anglesea-street, St. Lozell's, Birmingham.

19458\. **Improvements in electric accumulators or storage batteries.** William Phillips Thompson, 6, Lord-street, Liverpool. (Nathan Huntley Edgerton, United States.) (Complete specification.)

19450\. **Improvements in electric apparatus.** Thomas Edmund Marsh and Woodhouse and Rawson United, Limited, 88, Queen Victoria-street, London.

19469\. **Improved device for bringing the receiving instruments of telephones against the ears of the person speaking and returning the same to their position of rest, and also for circuiting the telephone in and out.** Richard Grove and Christian Lehr, jun., 70, Chancery-lane, London. (Complete specification.)

NOVEMBER 11.

19503\. **Improvements in apparatus for electric testing.** Arthur Albert Day, 60, Queen Victoria-street, London.

19504\. **Improvements in holders for incandescent electric lamps.** Frank Bryan, 11, Brackley-terrace, Chiswick, London.

19546\. **Improvements in alternating-current dynamos.** Wilson Hartnell, 8, Blenheim-terrace, Leeds, Yorkshire.

19551\. **Improvements in electrical means of advertising.** Alfred René Upward and Archibald George Buttifant, 2, Victoria-mansions, Westminster, London.

19553\. **Improvements in magneto-electric cut-outs or safety apparatus.** Vittorio Giovanni Lironi, 20, High Holborn.

19554\. **Improvements in electric switches.** Vittorio Giovanni Lironi, 20, High Holborn, London.

NOVEMBER 12.

19617\. **Improved exciting fluid for galvanic zinc carbon batteries.** Max Müthel, 1, Quality-court, Chancery-lane, London. (Complete specification.)

19625\. **Improvements in ceiling roses and wall sockets for electric lighting.** Alfred Grundy, 32, Brassey-square, Lavender-hill, London.

19630\. **Improvements in electric cables.** George Gatton Melhuish Hardingham, 191, Fleet-street, London. (Messrs. Felten and Guilleaume, Germany.)

19635\. **An improved electric apparatus for alluring and destroying insects.** Heinrich Count von Pückler, 45, Southampton-buildings, London. (Complete specification.)

NOVEMBER 13.

19966\. **Improvements in and connected with the application and utilisation of electricity in the driving of machinery, locomotion, and like uses.** Charles Percy Shrewsbury, 35, Queen Victoria-street, London.

19667\. **An improvement in lamps or apparatus connected with electric lighting.** Charles Percy Shrewsbury, 35, Queen Victoria-street, London.

19691\. **An improved device for ozonising air or gas by means of electricity.** John Charles Lawson, 11, Furnival-street, Holborn, London.

19704\. **Improvements relating to the application of depolarisers in electrolysis.** James Charles Richardson, 23, Claremont-square, Clerkenwell, London.

NOVEMBER 14.

19744\. **Improvements in alternating-current machinery.** Edward Whythe Smith, 66, College-street, Chelsea, London.

19778\. **Improvements in electric lighting apparatus.** Robert Arthur Dawbarn, 46, Lincoln's-inn-fields, London.

SPECIFICATIONS PUBLISHED.

1890.

15873\. **Multiple switchboards.** Bonne. (Mix and Genest Company.) 8d.

17035\. **Electricity motors.** Lea. 8d.

17394\. **Making or breaking electric circuit.** Vialet-Chabrand. 11d.

17852\. **Dynamo-electric generators.** Binko. 6d.

17861\. **Electrical conductors.** Marx. 6d.

19033\. **Electric switches.** Woodhouse and Rawson United, Limited. (Hinde.) 6d.

20100\. **Controlling supply of electric current to mains.** Willans. 8d.

21147\. **Insulating electrical conductors.** Boult. (Frédureau.) 8d.

1891.

10977\. **Galvanic batteries.** De Meritens. 8d.

15575\. **Galvanic batteries.** De Meritens. 8d.

NEW COMPANIES REGISTERED.

Isle of Wight Electric Lighting Company, Limited.—Registered by Deacon and Co., 4, St. Mary-axe, E.C., with a capital of £1,000 in £1 shares. The objects for which the Company is established are sufficiently indicated by the title.

Sectional Standards, Limited.—Registered by Wood, Bird, and Wood, 16, Eastcheap, E.C., with a capital of £3,000 in £10 shares. Object: to carry into effect an agreement made October 7, between William Pitt of the one part and A. Hemming, on behalf of this Company, of the other part, for the acquisition of certain letters patent relating to improvements in telegraph and other poles, and generally to manufacture and deal in the same. There shall be

ELECTRIC LIGHT INSTALLATIONS.

The specimen table given below shows certain information we desire to make complete, and we shall be glad if readers will assist us by sending such information as they may be able to give.

Name of Installation.	Address.	Electrical Engineer in Charge.	Assistants.
Bath Electric Lighting Co.	Dorchester-street	M. C. Olsson	—
Bournemouth and District	Bourne Valley	H. U. Wollaston	J. Shepherd.
Bradford Corporation Works	Bolton-road	S. W. Baynes	—
Bridlington		R. Railston Brown	—
Bright Bros.' Mill	Fieldhouse Mills, Rochdale	T. Humphreys	—
British Museum	Museum-street, W.C.	C. J. Sachs	W. Brew, S. Hart, G. Dryer, H. Hinton, J. Ferrant, T. Smith.
Bute Docks	Cardiff	T. Hunter	E. Johnson.
Cadogan	91, Manor-street, Chelsea, S.W.	J. Sayer	Three.
Carlow	Dublin-street	W. M. Meredith	W. M. Furniss, W. P. Kelly.
Central Savings Bank Buildings		J. Probert	—
Chafford and Devon Station	The Factory	Geo. H. Reed	C. Bartlett, W. H. Reed, G. S. Reed.
Chatham and Rochester	Victualling Office Wharf, Rochstr.	A. Maund	—
Chelmsford	Arc Works	A. H. Pott	H. B. Price.
Cowpen	50, Waterloo-road, Blyth	Ricardo Luis Mytton	H. Jeffrey, D. A. Jamieson.
Davies-street	Mayfair, W.	Ll. Foster	E. Fedden, C. Batho.
Deptford	Stowage Wharf	P. W. Dalton	J. H. McLean, A. Jacob.
Drury-lane Theatre	Drury-lane, W.C.	M. Horgan	W. Crawshaw.
Eastbourne	Junction-road	H. W. Wilkinson	L. Penson, G. Moller.
Eccleston-place	Belgravia, S.W.	C. O. Grimshaw	E. W. Munkhouse.
Electricity Supply Corporation	12, Maiden-lane, Covent Garden	H. A. Earle	T. Early.
Exeter	New North-road	T. P. Wilmshurst	H. D. Munro.
Fareham Electric Light Co.	Fareham	A. Blake	—
Galway Electric Company	Newton Smyth	J. E. Pearce	—
G.P.O.'s, East and West, E.C.		J. Probert	—
Henechsberg and Ellis	20, Islington, Liverpool	T. L. Miller	—
Houses of Parliament	Westminster	W. J. Prim	S. Maddick, W. Bowden.
Ipswich	Carr-street	W. B. Sisling	W. E. H. De Grave.
Keswick	Forge	W. R. Rice	—
Larne	Larne, Ireland	C. Watkins	J. Ingram.
Leamington	Wise-street	P. Still	—
Liverpool Electric Supply Co.	15, High-street	A. B. Holmes	—
Lynton and Lynmouth Electric Co.	Lynmouth	H. H. Brunn	F. Wallis.
Lyric Theatre	Shaftesbury-avenue, W.	W. A. Kirkwood	—
Madame Tussaud's	Baker-street, W.	W. V. Bonsor	—
Millbank-street	Westminster, S.W.	F. Newington	W. Robinson, H. H. S. Baker.
National Electric Supply Co.	Victoria-buildings, Preston	F. F. Bennett	S. Emerson, P. Bradley.
Newcastle Infirmary	Newcastle-on-Tyne		—
Newcastle-on-Tyne Elec. Sup. Co.	Pandon Dene	R. C. Jackson	A. B. Mountain, H. F. Proctor.
Norwich	St. Andrews	W. B. Sisling	E. R. Coote.
Notting Hill	Bulmer-place, Notting Hill Gate	G. Schultz	E. Edgcombe.
Paddington	150, Westbourne-terrace	G. B. Clifton	F. Newton, R. E. Winkfield, G. How
Portsmouth Town Hall	Portsmouth	J. Randall	Two.
Radford's	Southernhurst, Croydon	F. W. A. Radford	H. Palmer.
Reading Electric Light Depot	The Island	F. T. Yeatman	—
St. Austell	J. E. Veale, St. Austell	J. M. Coon	F. H. Headley.
St. Catherine's Lighthouse	Niton, I.W.	H. C. Millett	—
St. James's Hall, Wrexham	Albert-terrace, Everton, L'pool	R. Edwards	—
St. James's and Pall Mall Electric Light Co.	Mason's-yard, Duke-street, S.W.	S. T. Dobson	H. L. Leach, R. Wood, C. E. Price, [G. S. Maben.
St. Pancras	Stanhope-street, Euston-road	J. T. Baron	E. Maple, F. Everard.
Taunton	St. James and Middle street	H. E. Hunt	J. R. Blakie, W. O. Goodchild.
Thetford	St. Nicholas-street	R. Carter	C. Headley.
Victoria Station, L.C.D.R.	Pimlico, S.W.	Francis Rudall	R. H. Burnham, W. R. Sykes.
Waterford Electric Lighting Depot		P. Peters	—
West Brompton	Richmond-road	A. Gay	H. W. Bowden.
Weybridge	Thames-street	P. Mossop	C. Wells, C. Newman, H. Bishop, T. Horthorpe.
Wrexham Post Office	Albert-terrace, Everton, L'pool	R. Edwards	—

not less than three nor more than five Directors. The first shall be F. H. Lloyd, F. N. Cowell, and F. W. Drewett. Qualification, 10 shares. Remuneration not specified.

CITY NOTES.

West India and Panama Telegraph Company.—The receipts for the half-month ended November 15 were £2,309, against £2,602.

City and South London Railway.—The receipts for the week ending November 15 were £819, as against £783 for the week ending November 8.

Personal.—Mr. R. W. Paul has left Messrs. Elliott Bros., and commenced business at 44, Hatton-garden, E.C., as electrician and scientific instrument maker. Having had considerable experience of electrical testing and measuring instruments, both in construction and adjustment, he intends to devote special attention to them.

Woodhouse and Rawson United, Limited.—The Directors this week invited applications for the subscription of the following capital—viz., 10,000 ordinary shares of £5 each, being the balance of 60,000 shares; 13,000 preference shares of £5 each, being the balance of 50,000 shares, entitled to preference as to capital and to 7 per cent. preferential cumulative dividend per annum, together with a further 1 per cent. in every year in which the ordinary shares have received a dividend of 10 per cent. and upwards; and for £50,000 five-and-a-half per cent. 1891 debenture stock, being the balance of a total issue of £200,000, of which £65,500 is reserved for the repayment of a like amount of 6 per cent. debentures outstanding. Applications were to be sent in by Thursday.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Brush Co.	—	3⅜
— Pref.	—	2⅜
India Rubber, Gutta Percha & Telegraph Co.	10	19¼
House-to-House	5	5
Metropolitan Electric Supply	—	10⅜
London Electric Supply	5	2¼
Swan United	3½	5
St. James'	—	9¼
National Telephone	5	4⅝
Electric Construction	10	7¼
Westminster Electric	—	6¼
Liverpool Electric Supply	5 3	5¼ 2¼

NOTES.

The Electro-Harmonic Concert (ladies' night) takes place to-night at eight at the St. James's Restaurant.

Grimsby.—The contract for lighting the streets of Grimsby by gas has been relegated to the Lighting Committee.

Servia.—The Municipality of Serajevo have voted the sum of 450,000f. for the erection of a municipal central electric station.

Berlin Electric Railways.—The proposed electric railway of Messrs. Siemens and Halske, at Berlin, has been accepted in principle by the authorities.

Eastleigh.—The public lighting of Eastleigh, Hants, has been under discussion. Sixty lamps would be required, and the matter is adjourned till next year.

Society of Arts.—The paper by Mr. G. H. Robertson, F.C.S., at the Society of Arts, will be given on Wednesday next at 8 p.m., Mr. W. H. Preece, F.R.S., in the chair.

Swindon.—It has been resolved to advertise for tenders for the lighting of the town during the ensuing year, the price for gas being 33 per cent. more than that in neighbouring towns.

Royal Society.—A paper was read on Thursday before the Royal Society, by Mr. W. M. Bayliss and Dr. E. H. Starling, on "The Electromotive Phenomena of the Mammalian Heart."

Harrow.—The Harrow Local Board has accepted the tender of the gas company for public lighting for the current year. Meanwhile Messrs. Joel and Co. have been asked to quote a price for arc and incandescent lamps.

Newbury (Berks.).—The Corporation of Newbury have advertised their intention to apply for a provisional order during the next session. The agents are Messrs. Wyatt, Hoskins, and Co., 28, Parliament-street.

Dublin Castle.—Arrangements are being made for the introduction of electric light into the State apartments of Dublin Castle, and it is expected the necessary work will be completed before the opening of the next season.

London-Paris Telephone.—The convention between Great Britain and France regarding the regulations for the working of the telephone between London and Paris was signed on Nov. 18 at the British Foreign Office at Paris.

Smoking Concert.—Next Friday, December 4, the Old Students will hold a smoking concert at the Masons' Hall Tavern, Basinghall-street, at 7.30 p.m. Free tickets can be obtained from the Hon. Sec., 88, Queen Victoria-street, E.C.

Liverpool.—It is understood that the Liverpool Electric Supply Company will, during the ensuing session, apply to the Board of Trade for powers which will result in enabling the company to reduce their maximum rate to 8d. per unit.

Bournemouth.—The Bournemouth Town Council, as will be seen from the advertisement in another column, are inviting tenders for lighting the pier, pleasure gardens, and municipal buildings. The tenders are to be sent in on or before December 24th.

Southend Pier Tramway.—Major-General Hutchinson, of the Board of Trade, has forwarded his report of his inspection, with Major Cardew, of the Southend pier tramway. There were only a few minor things suggested as requiring to be carried out.

French Electrical Journal.—The name of the new French electrical journal, which we mentioned last week, is announced to be *L'Industrie Electrique*. The editorship and management will be in the hands of M. Hospitalier, who will reunite around him his old staff of the *Electricien*.

Harwich.—On Friday last, at the Harwich Town Council, Mr. Hill, in accordance with notice moved that the resolution of the Council applying for a provisional order for electric lighting be rescinded. The proposition was rejected by a large majority, only the proposer and seconder voting for it.

Blackpool.—The Blackpool Electric Tramway Company this year pays a dividend of 7½ per cent. The number of passengers carried during the year was 933,652, or over 120,000 more than last year. The number of miles run by the cars was estimated at 98,000, or about 6,000 more than last year.

Ludlow.—At the Ludlow Town Council meeting last week the question of electric lighting was brought forward, on the application of the Shropshire Electric Light and Power Company, Limited. Mr. Valentine proposed that the application be not entertained. The question was referred to the Watch Committee.

Carlow.—Mr. John Hammond, chairman of the Carlow Town Commissioners, has been authorised by the Commissioners to state that, in their opinion, the inhabitants of Carlow have good reason to be highly pleased with the electric lighting in that town, and cannot but regard the installation as being productive of great public advantage and utility.

Trowbridge.—A communication having been received from a firm of electrical engineers by the Trowbridge Local Board offering services, it was suggested that as the Board were paying £700 a year for gas, it was time to apply for an order, and either lay down the light themselves or sub-let the right to a private company. The clerk was instructed to obtain information and take the necessary steps.

Patents.—Mr. Lloyd Wise, C.C., in his presidential address before the Chartered Institute of Patent Agents, gave an important *résumé* of the present state of patent laws, dealing with the position of the institute, advocating thoroughness on the part of its members, and forcibly animadverting upon anomalies such as that the lapse of a patent in Denmark invalidates a patent in the United States.

Buda-Pest.—The Municipality of Buda-Pest have authorised the establishment of an electric tramway in the suburb Uj-Pest. The ownership of the central tramway of Buda-Pest is to be transferred to a special company formed in that town. Messrs. Ganz and Co. have laid the first cable for the distribution of electric light in Buda-Pest. It may be remembered that one of the first buildings to be lighted is the Royal Palace.

Liverpool Overhead Railway.—A scheme is on foot, under the auspices of the Liverpool Overhead Railway Company, by which railway facilities will be provided for the neighbourhood of Sefton and Prince's Parks, the line terminating in Ullet-road at a point between Linnet-lane and Lodge-lane. It is also proposed to extend the overhead railway a short distance to the northward, so as to make the terminus in Crosby-road, Seaforth.

South American Telegraph.—The official journal of Santiago, says the *Times*, publishes the fact that a concession has been granted to Sir John Pender, on behalf of the Eastern and Western Brazilian Cable Companies, for a line from Valparaiso to the eastern Chilian frontier, where Sir John Pender has undertaken to make a connection with Buenos Ayres. The American cable companies will also continue their lines to Buenos Ayres from here.

Finchley.—At a meeting last week of the Finchley ratepayers Mr. Tod moved a resolution to the effect that the meeting, whilst commending the activity of the Finchley Local Board in trying to prevent the establishment of any outside monopoly in electric lighting in Finchley, in view of information brought before it, considers that any application for a provisional order should be adjourned. The resolution was unanimously carried.

Halifax.—At a special meeting of the Halifax Town Council last week a resolution was adopted, on the motion of the Mayor (Alderman Davis), to apply to the Board of Trade for a provisional order to authorise the Corporation to supply electricity for public and private purposes within the borough; and that the town clerk be instructed to take all requisite measures for carrying this resolution into effect. The Mayor stated that by Dec. 21 next copies of the provisional order would be in the hands of the Council.

Deptford.—The London Electric Supply Company are giving their supply as usual. The mechanical breakdown recently alluded to did not absolutely stop the supply, though the other dynamos were overloaded, and the light was not up to pressure for a night or two. After working night and day on repairs the large dynamo was again started, and the light is now being supplied at full pressure of 100 volts at the lamps. It is expected that the number of lamps running will reach 40,000 by the end of the year.

Telephone Communication.—At the Plymouth Chamber of Commerce, last Friday, Mr. J. P. Brown introduced the question of Government control of telephones as well as telegraphs, and moved a resolution to the effect that it be a request to the Council to draft a resolution to bring before the Chamber, with a view to its being introduced for discussion at the forthcoming meeting of the Associated Chambers, in favour of the Government being called upon to take over the telephone lines throughout the country. The proposal was agreed to.

Worcester.—The Worcester Watch Committee recommends the Town Council to publish advertisements inviting persons or companies to submit plans, detailed descriptions, and estimates of the cost for constructing the works they think necessary for enabling the Council to supply electricity equivalent to 12,000 10-c.p. lamps, with the view, if the committee so decide, of laying such plans before an electrical engineer of eminence to advise the Council as to which, if any, of the tenders should be accepted.

Vacuum Tubes.—At the annual meeting of the Glasgow Philosophical Society, Dr. J. T. Bottomley, F.R.S., exhibited a series of vacuum tubes, some of which illustrated the phosphorescent effects which have been carefully studied by Crookes. The tubes were lent by Mr. Otto Müller, glassblower, West George-street. Other tubes constructed by Dr. Bottomley himself showed peculiarities as to the well-known striated condition of vacuum tubes, and one remarkable tube exhibited the peculiarity of conducting the current with greater facility in one direction than in the opposite.

Tiverton.—Elsewhere we give the text of the report of the borough surveyor, Mr. J. Siddalls, to the Council. We understand that the report is adopted, and that advertisements are to be issued inviting firms willing to undertake the powers of the provisional order for a term of years, the undertakers to specify (1) the system or systems they propose to employ; (2) the charges they intend to make; (3) the date on which they will commence the lighting; and (4) the terms on which the Corporation may at the expiration of the term purchase the plant belonging to the undertakers.

City Markets.—A startlingly suggestive proposal is to be brought before the City Markets Committee at its next meeting. Messr. Julius Sax and Co., electrical engineers, offer to light the whole of the Central Market avenues gratuitously for 21 years, and to wire every stall free of cost, according to the wishes of the tenants, and to maintain all repairs, if they are secured the lighting for the period named, the light to be supplied to the stallkeepers at the Board of Trade price. A numerously-signed petition from the markets is going up in favour of the proposal. The scheme, if carried, will prove a valuable boon to the market tenants at small cost and no cost to the Corporation.

Guildford. — At the Guildford Urban Authority last week a deputation, consisting of local gentlemen and an electrical engineer, attended as representatives of a recent public meeting with reference to the proposed lighting of certain houses by electric light. It was explained that the proposal was not to form a company to work for a profit, but an association amongst themselves to provide the light at cost, and they asked permission to lay wires across the roads. Mr. Cable moved that it was desirable that the Council should reserve the power. Mr. Taylor suggested that the matter should be referred to a committee of the whole Board, and this was agreed to.

Gloucester.—At the meeting of the Gloucester City Council on Tuesday, Mr. Clutterbuck moved for the appointment of a committee to consider the desirability of the Council acquiring the city gas works; and stated that in Birmingham the adoption of such a course had benefited the ratepayers to the extent of about £2,000,000. Alderman Bland moved an amendment to the effect that, having regard to the notices received of intending applications for provisional orders to supply electricity in the city, and the decision of the Council to keep such supply within their own control, it was inexpedient to consider the proposal. The amendment was subsequently withdrawn, however, and the original resolution carried.

Removal of Steel from the Eye.—Dr. G. Tatham Thompson, of Cardiff, has an interesting letter in the *Lancet* of Nov. 21 upon the removal of fragments of steel from the retina by means of electromagnets. He states that the only recorded cases previous to his own which were successful with retention of vision were those of Galezowski and Hirschberg. He mentions communications from Mr. Snell giving instances of this treatment, and also of Dr. Ferdinands, of Aberdeen, but in the last case a dense white cataract formed. The writer mentions that the adoption of the form of instrument was the result of a hint from one of the Cantor lectures of 1890. The patient operated upon by him still retains his vision.

The Prevention of Tramway Accidents.—The Portstewart Steam Tramways Company (in connection with the Belfast and Northern Counties Railway Company) have had some of their tramcars fitted with the Porri patent emergency brake, to act automatically in the event of a car breaking away from the engine, and also for application by hand when required. The brake was some time ago tested by Major-General Hutchinson, R.E., and approved by the Board of Trade. It has been further approved by the Board of Trade inspector at Belfast, and the inventor (a Grimsby journalist) has just been informed by Mr. B. Malcolm, the company's engineer, that in the trials made to test it the brake proved satisfactory.

Underground Railway to Baker-street.—Besides the railway to the Mansion House we have already alluded to, a Bill will be promoted in the ensuing session of Parliament to obtain power to construct an underground railway from Waterloo Station, passing under the River Thames to the west side of Hungerford Bridge to a point near the Charing Cross Station of the Metropolitan District Railway. Thence the railway will proceed under Northumberland-avenue, Trafalgar-square, Haymarket, Piccadilly-circus, Regent-street, Regent-circus, Portland-place, to its termination at Baker-street Station. This could not but prove a very serviceable line. The schemes now proposed, if carried out, will certainly give a very fine set of cross town routes, and make the metropolis the best-served town in the world for suburban rapid transit.

Colliery Lighting.—The Local Board of Featherstone, near Pontefract, at its next meeting will have to consider a proposal to light North Featherstone and Ackton by electric light. Lord Masham, now the owner of the Ackton Hall estate, proposes, with the Local Board's consent, to light up the portion of the Board's district known as North Featherstone and Ackton with electricity under certain conditions, which, if accepted, will give better light and prove a great saving to the ratepayers. Already Lord Masham has commenced preparations for the sinking of two new shafts to the silkstone bed of coal under his estate at Ackton. The estimated depth from the surface is 610 yards. The work at the surface and in the shafts will be carried on by means of the electric light.

Brighton.—The Brighton Town Council had before them last week the proposal to purchase the goodwill of the Brighton and Hove Electric Light Company for £7,000, and the request of the Lighting Committee for power to borrow £8,500 for the purpose of laying further mains and other works. On the motion of Alderman Sendall, the Council resolved itself into committee to discuss the report, and the following resolutions were adopted: (1) "That the Council be recommended not to agree to purchase the goodwill and undertaking of the Brighton and Hove Electric Light Company on the terms contained in the report," and (2) "That the Council be directed to apply to the Local Government Board for sanction to borrow £8,500, for 30 years, for the purpose of the electric lighting undertaking." Both resolutions were afterwards carried by the Council.

Berlin.—The report of the Berliner Electricitäts Werke for the past year shows a considerable increase in output. The number of subscribers has risen from 872 to 1,314, and the lamps wired from 74,959 to 104,100. It is interesting to notice that the increase of lamps is not proportional to the increase in subscribers, the first subscribers being at first those requiring large numbers of lamps, while now the majority of subscribers are those using only two or three lamps each. It is expected that the total of lamps will reach 25,000, or even 30,000, by the end of the present financial year. The current for driving electric motors has had a remarkable increase, bearing out the ideas we have so often promulgated, the consumption having risen from 69,591 to 274,457 kilowatt hours. The electric light has absorbed 10,530,000 horse-power hours, corresponding to a lighting power of 64,600,000 lamp-hours of 10 c.p.

Wickwar.—It is always interesting to see what can be done by careful engineering and enterprise. Certainly the little town of Wickwar, in Gloucestershire, is a good example, for it now has rather more than one statute mile of road, including the High-street, lit by 20 incandescent electric lamps, at a total cost of £15 a year. This installation is really a circuit run from the brewery dynamo, and everything connected with it has been done as cheaply as possible, consistently with efficiency, bare aerial copper wire being used. The whole installation is regarded as a complete success, though, of course, some of the lamps in the open roads are a long way apart. It is now doing its fourth season, for like most country places the public lamps are only lit during the winter. The electrical engineer in charge is Mr. F. Graham Ansell, F.C.S., who has now quite an extensive installation, for a small town, under his care.

Sir William Thomson's Portrait.—Some months ago, at a private meeting of Glasgow gentlemen, it was agreed to ask Sir William Thomson to sit for his portrait (in order that it should be presented to the University of Glasgow) as a mark of the respect in which he is held, in recognition of his great and invaluable contributions to scientific discovery, and also as an associative link on his election to the presidentship of the Royal Society. It was at the same time determined that a replica should be presented to Mrs. Thomson. Mr. Herkomer was entrusted with the work, and the portraits have now been delivered. It has been arranged that the presentation should be made by Mr. A. J. Balfour, who was an original subscriber, and is an old friend of Sir William Thomson's, on the occasion of his visit to the city for the purpose of delivering his rectorial address. Principal Caird will acknowledge the presentation on behalf of the university. The presentation is to take place to-day (Friday).

The Steam Loop.—Some year or two ago a simple invention for the better economy of boiler use was introduced in America under the name of the "steam loop." This arrangement, which is simplicity itself in both principle and practice, seems to have at last taken great hold amongst engineers in the States, and has been installed by thousands. In England it has also been begun to be adopted with remarkably favourable results, and seems worthy of attention by those in charge of large engines where economy of steam consumption is the careful consideration of the engineers in charge. An installation of the steam loop was to be seen in action at the Brewers' Exhibition. We see it stated that the originator of the device was Mr. James H. Blessing, of Albany, N.Y. In principle the idea is a complete loop of small steam-pipe round from the main steam-pipe back to the boiler; steam pressure is kept in the small loop, and the water of condensation runs back by gravity at not much below the temperature of the steam. It dispenses with the use of steam-traps, and uses both the water of condensation and its heat with considerable economy in fuel.

Lambeth.—At the meeting of the Lambeth Vestry last week, a report was received from the Electric Lighting Committee, stating that they had very fully considered the advisability, in the public interest, of the Vestry applying to the Board of Trade for an order under the Electric Lighting Acts to light the parish with electricity, rather than allow any company to obtain an order and so acquire a practical monopoly. The present was a very suitable time for the Vestry to reconsider its action with reference to the electric light, as, although the House-to-House Company obtained an order for nearly the whole parish, their original and extended time to do so under the order had expired, and unless the Board of Trade specially enlarged the time the order would be cancelled. Two new companies had given notice of their intention to apply for an order for Lambeth, and therefore, if the Vestry thought fit to apply for an order, action should be taken at once. The committee recommended the Vestry at once to apply for a provisional order. Mr. H. Dann, in moving the adoption of the report, pointed out that Prof. Robinson in his report to the St. Pancras Vestry gave it as his opinion that the Vestry could supply electric light at 4½d. per Board of Trade unit, the initial price proposed by the companies being 7d. or 8d. After considerable discussion, the committee's recommendation was adopted, and it was determined to ask the Board of Trade to revoke the order granted to the House-to-House Company.

Cardiff.—The report of the sub-committee of the Cardiff Town Council, who, together with the borough engineer, the town clerk, and Mr. Massey, visited Frankfort to inspect the electric light, was presented at the meeting on Tuesday. The expenses came to about £27 each; these were passed, Councillor Beavan objecting. The report of the sub-committee estimates the cost of a central station and mains to be £30,000. They consider the concentration of the generating power at one point with high-pressure transmission to be the most efficient, any danger being overcome by proper insulation and laying the mains underground. The best examples of public lighting they had seen were those at Brussels and Paris with arc lights and gas. They suggest the same arrangement for Cardiff, the arc lights to run till midnight. As the result of very full enquiries, light for light and hour for hour, they find electric light would cost two and a half times that of gas, economy being gained in facility of turning off and saving in decoration. They looked to a considerable use of electric motors, and an overhead system of electric tramways, as at Leeds. The present cost of gas in Cardiff is £650 per annum. To light the same streets partly by electricity and partly by gas in the manner recommended by the sub-committee, the borough engineer estimates the total cost at £948 per annum.

Newcastle Assembly Rooms. — The Assembly Rooms, one of the oldest and most noted buildings in Newcastle, opened in 1776, has just been lighted throughout by electric light. The current is derived from the mains of the Newcastle and District Electric Lighting Company, and is carried out from the company's apparatus to main and subsidiary switchboards in the Assembly Rooms. The lighting of the larger ballroom is carried out very handsomely with about 200 electric lamps. All the fine old cut-glass fittings have been transformed into electroliers, and this has been done so neatly that not so much as a sign of a wire is to be seen, for white silk conducting wires have been used inside the glasswork. It is an interesting item in this installation that these electroliers have served through three great periods of artificial lighting. They were first of service as chandeliers, afterwards being altered to act as gasaliers, and now they are used as an elegant setting for the electric light. The general result is most satisfactory, and has called forth the unanimous approval of audiences. A similar mode of installation has been adopted for the small ballroom, and the reception-rooms have been provided with special fittings for the display of the light. The total equivalent number of 10-c.p. lamps in the building is 440. The installation in the ballrooms was completed within the brief space of 10 days. Messrs. D. Selby Bigge and Co., electrical engineers, Newcastle, carried out the whole of the electric part of the work, and the way in which it has been accomplished reflects great credit on this firm and its staff.

Watt's Electrolytic Zinc Process.—It appears that the principal feature in this process is the employment, as an electrolyte for extraction of zinc, of a compound solution formed from a mixture of sulphate and acetate of zinc. It has hitherto been found that when sulphate of zinc alone has been used for the electrolyte, especially when the object in view has been the extraction of zinc from its ores, necessitating the use of insoluble anodes, that the metal generally deposited in a granular or powdery condition unsuitable for melting, while not unfrequently crystaline growths, or "trees," formed on the corners and edges of the receiving plates, often approaching and, indeed, coming in contact with, the anodes, and thus short-circuiting the current. Another serious objection to the zinc sulphate solution as an electrolyte appears to be that when the solution becomes even slightly acid, from loss of zinc during the deposition of the metal upon the cathodes, the free acid quickly attacks the deposited zinc, liberating hydrogen, and polarisation is thus set up as a matter of course, and the operation brought to a standstill. In Mr. Watt's process, even when the liquors are decidedly acid from the cause named, there is no liberation of hydrogen and no polarisation. With the aceto-sulphate of zinc solution of Mr. Watt, the deposited metal is uniformly a perfectly "reguline" character, very brilliant in appearance, and quite free from fibrous or branching crystals of the metal, which deposits upon the cathodes in a close, compact, and sometimes nodular, or rounded in form, rendering the deposit well suited for melting without loss of metal. It is to be hoped that this highly interesting and promising process of Mr. Watt's, which has thoroughly stood the tests of expert examination, will be taken up in practice.

City Lighting.—The City of London Electric Lighting Company have requested the Commissioners of Sewers to extend the period named in the contracts between the Commission and the Brush and Laing Companies for the public lighting of the City. They state that when their company came into existence in July the latter companies had not been able to do more than make preliminary arrangements for provisional lighting to demonstrate to the Commission the nature of the work proposed to be undertaken. When the company took over the contracts, with the sanction of the Commission, in August, leaving only six months for the obligatory term specified in them unexpired, nearly everything remained to be considered and done in preparation for the large expenditure of capital which the great engineering work of supplying electricity to the City of London naturally required. The company had considered it wise, in the interests of all parties, to call in the best advice, so that the proposals of their technical advisers should be fully confirmed, and so that no part of their work, which might eventually entail an expenditure of nearly a million, should be put in hand without careful forethought. Pending the results of these investigations, the company had already expended large sums in preparations. The company assured the Commission that no time had been or would be lost in these essential preliminaries. In these circumstances the company asked that an extension of time for at least one year might be granted in the contracts for the public lighting. The consideration of this request will come before the Commission at their next meeting. The contracts, we believe, stipulated for 50 arc lamps to be erected every three months after February, 1891. Considering the fact that the City authorities have only just settled on the form of lamppost, and that those now erected were put up by the Brush Company at their own risk in order to get at least 20 lights running, an extension of time seems reasonable, and hardly needed the fuss that has been made about it. At the same time, we believe the City of London Company do not anticipate that they will require all the time they ask for.

St. Pancras Exhibition Addresses.—The Vestry of St. Pancras is evidently resolved not to do things by halves with regard to its electric lighting scheme. Not content with establishing its central station, it held, as we know, a most successful local electrical exhibition at the Vestry Hall to show the inhabitants what it was intending to do, and now is issuing a very handy little pamphlet giving much information in a understandable form, in the shape

"Electrical Exhibition Addresses" by Prof. Robinson, W. H. Preece, Mr. Slatter, and Mr. Andrew Sweet irman of the Electricity Committee), with an introduc- by Mr. Thos. Eccleston Gibb (published by Mitchener, nden Town). It constitutes an extremely interesting mming up in a small space of public information upon the ject of electric lighting from several points of view: that he consumer, municipal authority, engineer, and capitalist. Eccleston Gibb speaks of the history of the electric ating legislation, especially with regard to the part St. ncras has uniquely played in the establishment of ndon municipal stations. "The Corporation of London," says, "which ought to have set an example, has rendered its powers to the City of London Electric ghting Company, and the honour is left to the Vestry of Pancras to be the pioneer in London of municipal terprise in relation to electricity. Everything," he goes to add, "is now ready. Contracts for supplies equal to arly 6,000 lights have been sealed by the Vestry, and is before a simple public lamp has been lighted." With gard to the question of loan, Mr. Gibb alludes to the fficulty with the County Council, and says, "If there is y lack of power, Parliament must be asked to ake such amendments as will put the Vestry and cal authorities in at least as good a position as rivate companies." The addresses of which the book onsists are those of Prof. Henry Robinson, on "The Cost f Stations," and Mr. Preece, on "The Poor Man's Light," which we have already given; also an address by Mr. Slatter, giving elementary electrical information, and rices for fitting up houses of different sizes. Mr. Andrew Sweet deals with the question of the raising of capital and the probable revenue. The book costs sixpence, and might well be circulated in other districts than that of St. Pancras.

The Electric Light in a Gas Works.—The following interesting note appears in the *Journal of Gas Lighting*, which cannot usually be accused of giving commendation to electric light in any form. However, better late than never. It says: "The engineer and manager of the Dewsbury Corporation Gas Works (Mr. Charles A. Craven) occupies now a rather unique position in the gas industry, inasmuch as he has adopted the electric light in a portion of his works. It appears that for some time considerable difficulty was experienced in carrying on operations in the purifying-house, especially when extra work had to be done in the winter season, owing to the inadequate light furnished by the safety gaslights placed in the walls. Considering how he could safely obtain more light for his men, Mr. Craven decided that it could best be done by adopting electricity, and accordingly recommended the Corporation to try incandescent electric lamps. To this they agreed, and the use of the light in the purifier and engine houses commenced on the 22nd ult., and, so far, this novel application of electric lighting has been satisfactory. As the plan may commend itself to the notice of some of our readers, we give a few particulars of the installation, which Mr. Craven has recently forwarded to us. The lighting is at present done by four 16-c.p. lamps for the engine-house, and 10 similar lamps for the purifier-house, but it is in contemplation to replace two of the lamps in each house by others of higher power. The dynamo was specially made by Messrs. Austin and Myers, of Armley, Leeds; and up to now it has run well. It is located in the engine-house, and is driven direct from the flywheel of the stationary engine. To the foregoing details, Mr. Craven adds the following general remarks: 'Some of my brethren in the gas profession seem much struck with the novelty of the idea. I am told that it is "a funny thing to bring the electric light into gas manufacturing operations." Well, I reply that our gas is frequently used in providing motive power to produce the electric light; and that being so, why should not we utilise the light for any purpose where it can advantageously be used? If I dare put gas lights where I have placed incandescent lamps, I could get as much light as I want, and at a cheaper rate than by using the electric light. Our surplus power, however, enables us to produce the light without much extra cost. We are intending to make some few additions to the fittings of the lamps, which will add somewhat to the cost, but which will at the same time be an additional safeguard.'"

Factory Lighting at Dundee.—Electric lighting is making great progress in Dundee, factory after factory having been lighted, and most of the largest factories are either lighted or preparing so to do. The most important installation yet introduced is that of Messrs. Grimond, Bowbridge Works. This installation, which has been erected by Messrs. Lowdon Bros., of Dundee, is amongst the largest in the kingdom. The factory alone covers four acres, and there are 950 looms under one roof. The installation is fitted up on the series parallel system, with a saving of 30 per cent. in copper. There are in the works three lamps of 300 c.p. each, two of 200 c.p., 85 of 100 c.p., 70 of 50 c.p., 54 of 32 c.p., and 1,960 of 16 c.p. each, which is equal to a total of 2,763 lamps of 16 c.p. each. For the ordinary lighting of the works there are two large dynamos of the Edison-Hopkinson type, made by Messrs. Mather and Platt, Manchester. They are each constructed to give an electrical output of 300 amperes and 100 volts at a speed of 580 revolutions per minute, equal to the supply of 2,000 lamps of 16 c.p. each. The heavy mains are carried to distributing switchboards for each department, fitted with double-pole switches and fuses. The Edison-Swan lamps are fitted with bayonet-jointed holders by flexible cord from a porcelain ceiling rose with safety fuse combined, and fitted with enamelled shade over the lamp. In all, 35 miles of cable and wire is used. The preparing-rooms are lit by Sunbeam lamps of 100 c.p. to 300 c.p., in the spinning-rooms two lamps of 16 c.p. are hung on the passes, and in the winding-rooms 16-c.p. lamps are placed 10ft. apart. The looms have also 16-c.p. lamps hung above them. A prettier sight is not to be seen in Dundee than when this place is illuminated. Down the long passes and on each side are lamps, the bright rays of which bring out in relief the looms, moving as if by some unknown force (the shafting being all underground), and the hundreds of busy workers who control the machinery. The calendering department, which adjoins, is illuminated by lamps ranging from 16 c.p. to 100 c.p. The recreation hall, which is another instance of the Messrs. Grimond's solicitude for their workers' welfare, is brilliantly lit by eight 100-c.p. lamps suspended from the roof in large diffusers, which make the light very soft and agreeable. On the "stage" there have also been placed 10 16-c.p. lamps, which serve as footlights when an entertainment is given. There is also a night or "police" circuit run through the works. It has two compound-wound dynamos made by the Electric Construction Corporation, Wolverhampton, and driven by a separate engine. Each dynamo is capable of lighting 200 lamps of 16 c.p. each, and either machine can be driven separately or both at once, as required. One dynamo is kept running all night. Hand lamps of 40 c.p., with flexible conductors, are also used when repairs are carried on. In the street outside four 100-c.p. and 10 16-c.p. lamps are fitted. On any alarm of fire the hose is run out, the door opened, and the whole night circuit is thrown on automatically. The installation is a great credit to both owners and contractors.

UNDERGROUND LIGHTING MAINS IN PARIS.*

BY E. DIEUDONNÉ.

(Continued from page 377.)

Continental Edison Company's Mains.—The district conceded to the Continental Edison Company in Paris comprises the Grand Boulevards as far as the Opera on one side and the Boulevard Saint-Denis on the other, radiating towards the Rue Richelieu and Rue Montmartre, the Bourse, and the Rue Lafayette, and extending to the northwest to the exterior boulevards.

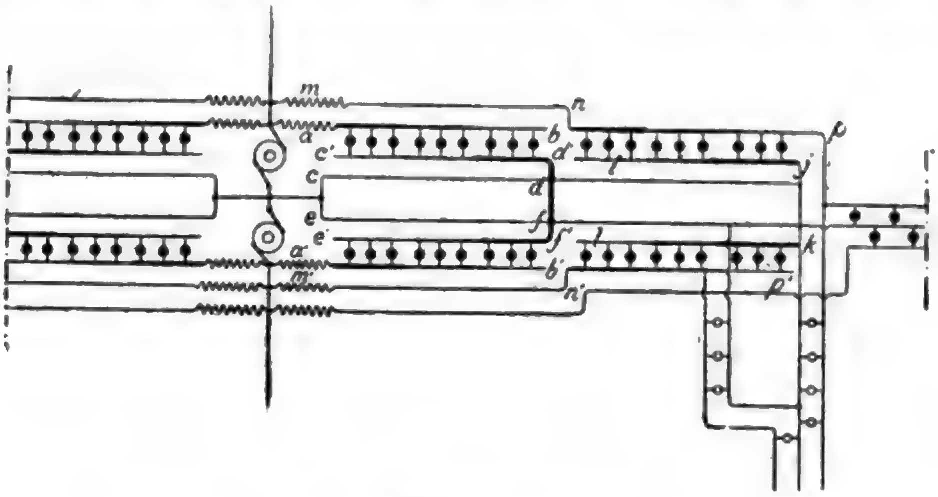

Fig. 49.

This district is supplied by two separate central stations—one situated in the Avenue Trudaine, which furnishes current to the upper part, and the other, in the Rue Faubourg Montmartre, supplies the lower part of the "sector."

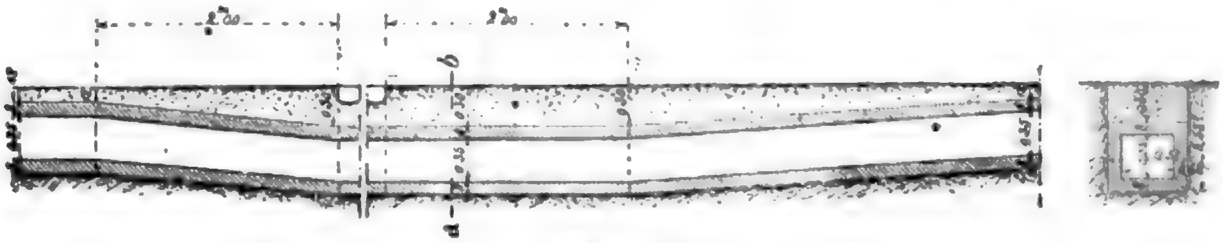

Fig. 50.

Each generating station end the mains attached are quite separate, although it is possible to connect the two together for mutual support by a trunk main passing between the two stations.

The method of distribution chosen is that of the three-wire system. The current is led into the outer wires at a pressure of 200 volts, the intermediate conductor dividing the pressure into two sets of 100 volts in the lamps. The dynamos are grouped two in series.

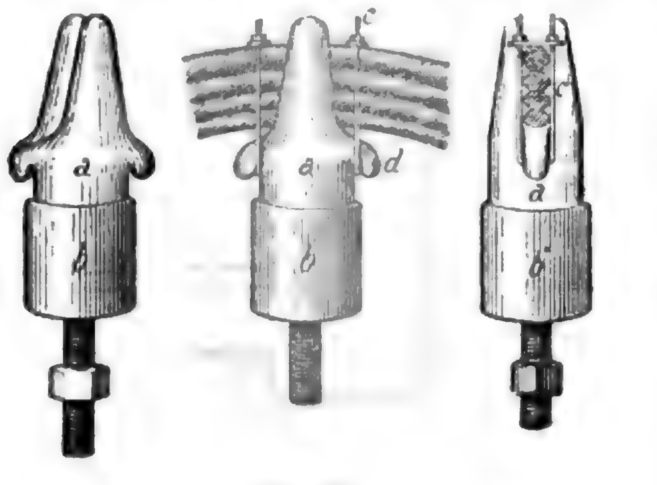

Fig. 51.

The arrangements of mains differ in the two stations; that of the Avenue Trudaine has both distributing and feeder mains, while in the Rue Faubourg Montmartre, where the situation being very central to the district seems to justify it, the plan of distribution by opposition or by balanced means is adopted. The cross-section of the conductors increases gradually on one side and decreases in the same proportion on the other, so as to maintain a uniform total area. This disposition has permitted the zone of service to be enlarged without passing the limits of variation of potential fixed. The conical form of the conductors is obtained simply by the superposition of cables of various lengths on the same insulators.

In this system the length of main conductor in the circuit of each lamp remains invariable. If the calculation of the conductors for the hypothesis of the illumination of the total number of lamps gives a constant density of current, the pressure will remain uniform at all points. The arrangement comes to the same thing as if each lamp had a special main circuit of invariable extent, the parallel branches of the circuits being gathered together. At the moment of extinction of a part of the lamps, the density of current no longer remains constant, and therefore variations of potential occur.

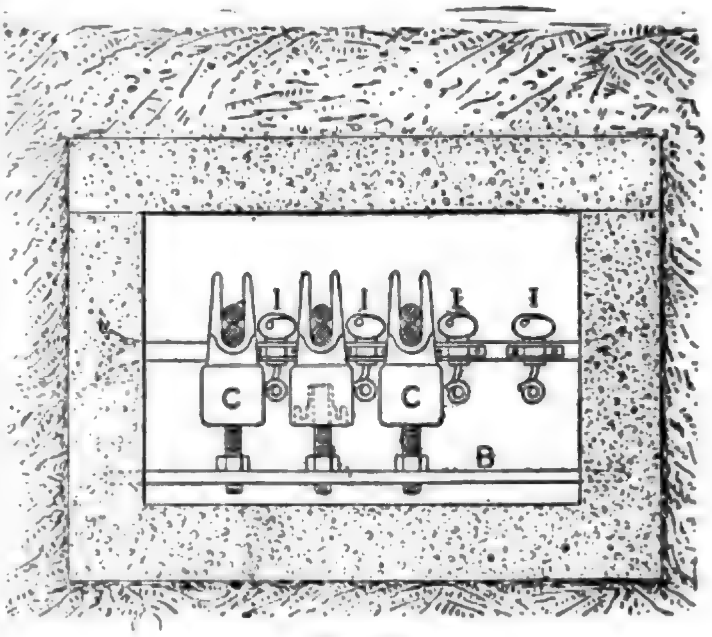

Fig. 52.

Two kinds of regulation are therefore required in actual practice. In the first place, the constancy of the pressure at the station end is maintained by a general regulation affecting the whole of the dynamos, and further, according to needs, special rheostats are brought into play inserted in each of the circuits.

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* From *L'Electricien.*

The system of distribution is shown diagrammatically in Fig. 49. This shows the arrangement of five double circuits. The neutral wire is doubled to facilitate laying.

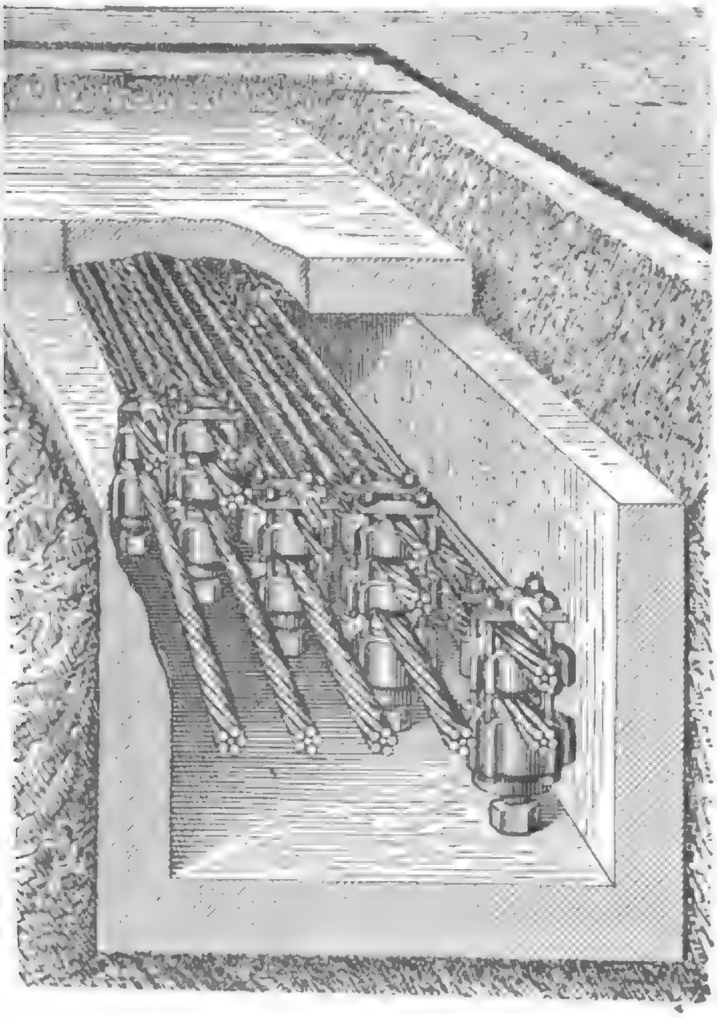


FIG. 53.

All the main conductors end at the station. The two portions of each complete circuit alternate from one side of the pathway to the other to obtain a better division of the lamps on each.

We shall not further deal with the considerations which have led to the use of this method of distribution, but pass at once to the actual process of laying the mains.

The Edison Company were the first in Paris to use bare copper laid on insulators in underground culverts. As a faithful historian we ought here to acknowledge this fact.

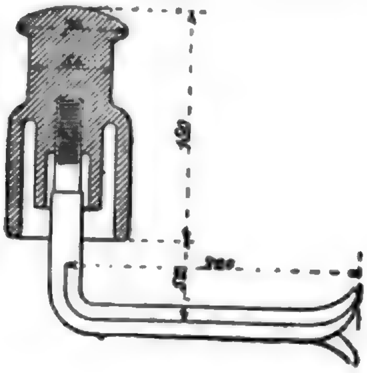


FIG. 54.

The culverts, of various cross-sections, are of concrete, covered in by slabs of the same material jointed with cement. They follow the natural gradients of the pavements under which they are laid. The top of the culvert is laid about 20 cm. (7¾in.) from the pavement level, this being increased to 30 cm. (say 1ft.) at gateways (see Fig. 50). The company has been authorised to pass in exceptional cases in trenches at the crossing of certain streets, on condition of lowering the top of the culvert to 1·40 metres (4½ft.) below the surface. But, speaking generally, the crossing of streets is carried out in a vaulted gallery, whose extremities end at vertical pits, as we have previously described in the article.

The dimensions of the culvert are usually ·355m. (12in.) high by ·25m. to ·40m. (10in. to 13in.) wide, according to the importance of the streets; at the points where the roads curve the width is somewhat increased.

The bare cables are laid in the culvert upon cast-iron saddles, Fig. 51, sealed with sulphur upon double bell porcelain insulators, carried by threaded metal standards fastened by bolts upon a cross-bar built in to the sides of the culvert. The distance between these bars is about two metres (6ft. 6in.). The cables are superposed between the forks of the saddles, and are kept in place by binding stirrups, Fig. 51, fastened to lateral lugs cast on the saddles. The arrangement is clearly shown in Fig. 52, which also shows another suppoit furnished with special insulators for the purpose of receiving the pilot wires in the slot made in the top of each. The distance from centre to centre of insulators is ·10 metre to ·12 metre (4in. to 4½in.). Before being fastened in the stirrups the cables are tightened up by small differential pulley stretchers.

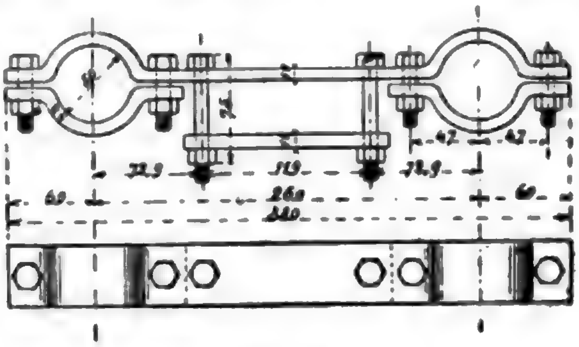


FIG. 55.

The arrangement just described in its principal details is employed in the distributing mains of the Faubourg Montmartre station. It occupies a considerable space, which increases with the number of cables to be carried. Its use would hardly be justified in cases where the number of conductors is great. Questions of economy have suggested a different arrangement for the distributing system of the station at the Avenue Trudaine.

In this we have a three-wire system of distribution with feeders—that is, a system comprising distributing mains properly so-called, together with feeding mains. It being desirable to lay the feeders in the same conduit as the distributors, the number of cables was largely increased, consequently it was necessary to find the means of laying them conveniently in culverts of the usual dimensions; in the first place, without danger to regular running, and in the next, without increasing the expenses of trenches and culverts.

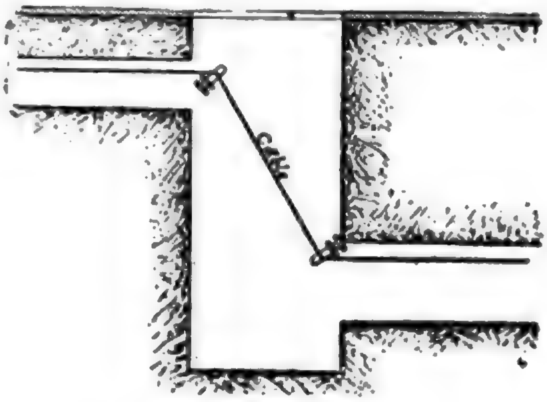


FIG. 56.

So far as regards safety of working, it was not difficult to observe that the differences of potential between the various feeders of the same polarity were too slight for them to be of any great inconvenience on placing them near to each other. In the compensating cable the differences of potential are still more insignificant; hence, to lay these together throughout the whole length was a step at once taken.

The appearance of the culverts arranged in this manner is seen in Fig. 53. Down the centre, the insulators carry the distributing cables, and the group of compensating cables; and at each side, towards the walls, the feeders of the same polarity. The insulators are modified to carry cables ranged in vertical groups: the first cable is laid upon a bell insulator; on this cable is placed a plate of insulating material suitably shaped; this plate carries in its turn a second cable, upon which is placed a similar insulating plate, and so on alternately till the last cable is laid. A quadrangular metal plate, slotted at its angles to allow passage for bolts, is placed above the whole and tightened by means of nuts. Both bell insulators and insulating plates are similarly slotted. The pilot wires are mounted on bobbin insulators carried on the top of the pile of cables by means of small collars.

In the culverts for crossing streets, two insulators, Fig. 54, are clipped by a double collar; the cables are laid side by side and kept in place by a stirrup, Fig. 55. If the pits are not very deep the cables are laid diagonally, supported by insulators, as shown in Fig. 56.

The Continental Edison Company also make use of the square glazed earthenware conduits employed by the Société de Transmission de la Force et d'Eclairage; in the places which are narrower still the cables are insulated and enclosed within pipes with covers, and made of a very hard earthenware.

The connection together of two bare cables is brought about by laying them one above each other, for a minimum length of 10ft., and pressing them firmly together by stirrups and screw bolts.

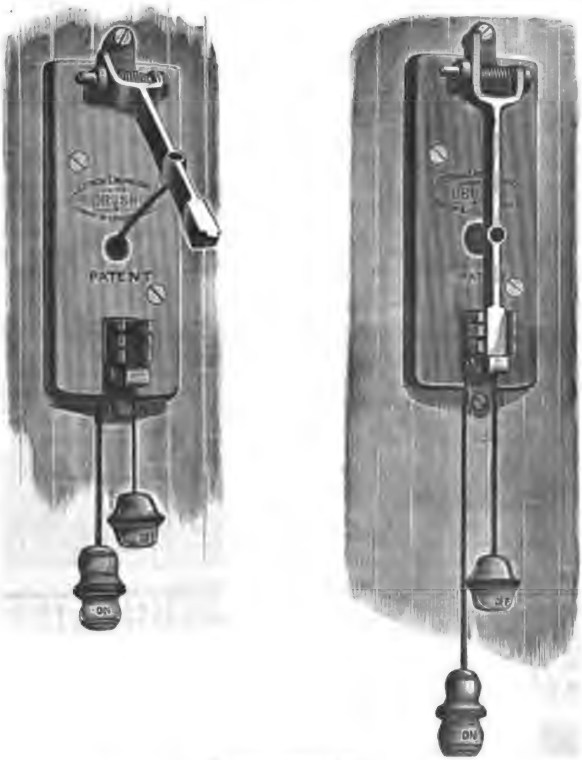
The service mains are placed in the ground in a casing of pitched wood, covered in with a bed similarly prepared. These cables are lead-covered. To connect them to the bare conductors of the main they are bared for a length of 12in., and pressed against the larger cables by the means of screwed stirrup straps as the others.

The cables leave the central stations carried along the walls of a general subway, in which they are ranged in the order they are to occupy in the culverts.

(To be continued.)

THE BRUSH HIGH-TENSION SWITCH.

The illustrations herewith show the form of switch adopted by the Brush Electrical Engineering Company for their high-tension work for central station switchboards. In this switch the desirability of obtaining quick and long break, without the necessity for actual contact of the attendant's hand, are very simply satisfied. The long-hinged contact-piece is furnished at the hinge with a strong coiled spring, which maintains it in the "off" position at a distance of some 6in. or 8in. from the other contact. This second contact takes the form of double-slotted springs, and has below it a strong spring catch. The switch itself may be placed overhead quite out of ordinary reach. On pulling the silk cord marked "On," the contact comes into place, and is retained by the spring catch. On pulling the knob of the cord marked "Off," this catch is released and the contact arm flies up, making a long and quick break. These switches have been employed, amongst other installations, at the Bath central station, and have been found to give uniformly good results. The cords shown may, of course, be made of any suitable length, and



Brush High-Tension Switch.

the actual contacts are thus entirely out of the way of the attendant who has to work them. The switches should have a large field of usefulness outside the Brush Company's own installations.

MIX AND GENEST'S APPARATUS.

The application of electricity to all kinds of commercial and useful undertakings has taken such giant strides during the last 10 years, that it is indeed difficult for the ordinary business man and engineer to keep pace with all the means so obligingly put at his disposal. We are not now speaking particularly of dynamos, electric light apparatus, or electric motor machinery, so much as with reference to those thousand and one fields of everyday commercial or professional life that electricity has invaded and conquered. Few, indeed, will be the activities of mankind in the coming years that electricity does not play some more or less considerable part.

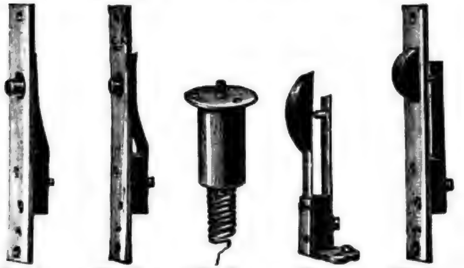


Fig. 1. Fig. 2. Fig. 3. Fig. 4. Fig. 5.

Door and Window Contacts.

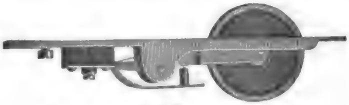


Fig. 6.

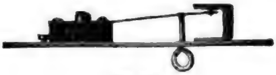


Fig. 7.

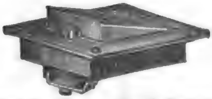


Fig. 8.—Floor or Tread Contact.

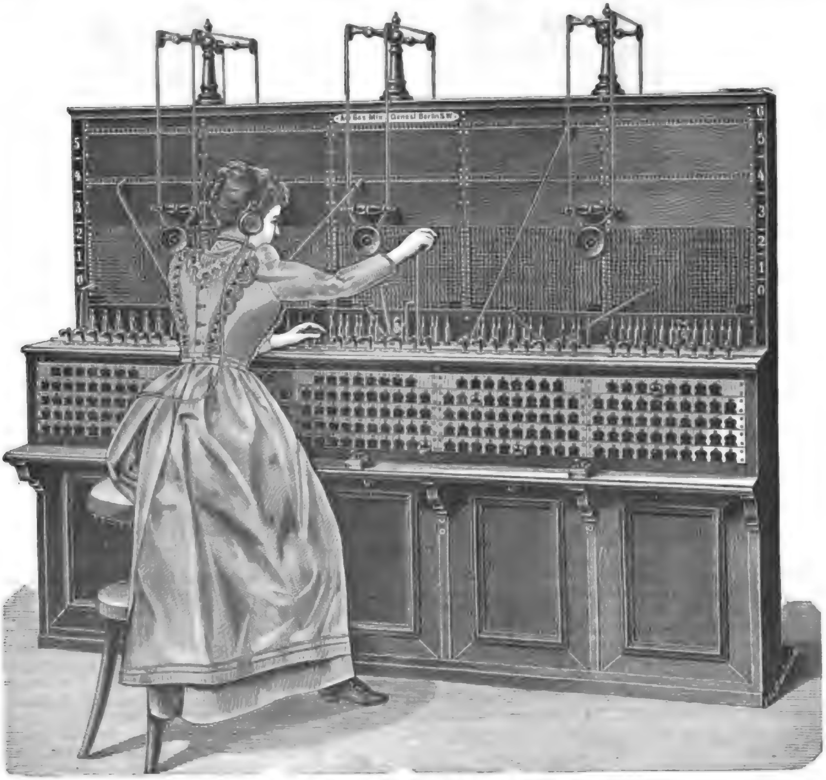


Fig. 9.—Multiple Switchboard for 6,000 Subscribers.

We are led to these reflections by the perusal and examination of the very interesting catalogue, now in its tenth edition, issued by the International Electric Company, the depôt of Messrs. Mix and Genest, Limited. There in neat and telling illustration, printed in a large and handsome book, appear innumerable instances of the various applications of what might be termed light electrical work for every conceivable purpose. Electric bells naturally form a considerable portion of the earlier part of the book, and we have some spirited shapes, as of gnomes hitting with all their might upon a huge church bell—a quaint device that should commend itself to artistic householders. The sets of dry batteries and bells are made up in a very convenient, cheap, and portable form with the Mix and Genest dry battery furnished with a hook above for the wall, and below, attached to the battery, is the bell itself. We have already described and illustrated the company's ingenious indicator movement, of which there

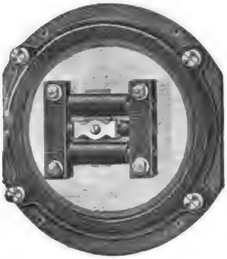


Fig. 10.

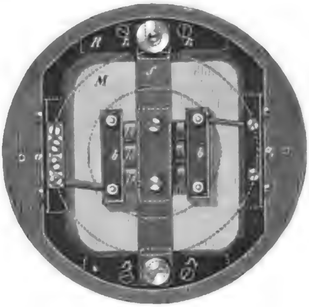


Fig. 11.

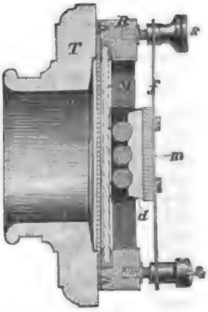


Fig. 12.

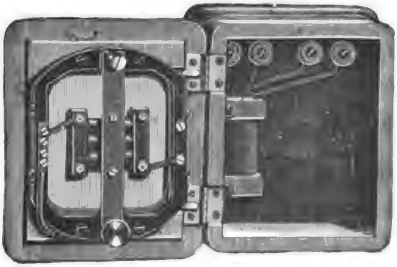


Fig. 13.

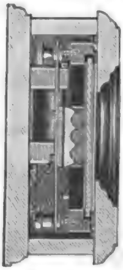


Fig. 14.

Mix and Genest Microphones.

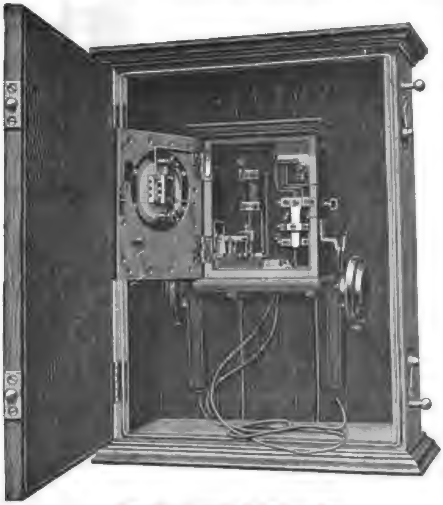


Fig. 15.—Airtight Telephone Set.

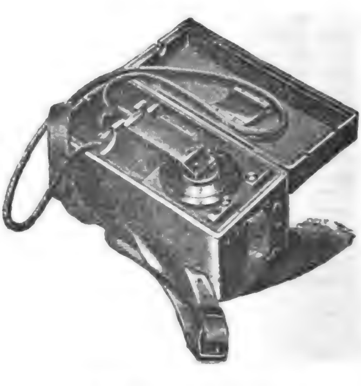


Fig. 16.—Portable Telephone Set.

are several, particularly that to which the name of the "New Era" indicator has been given, so we pass to other matters.

Pushes in abundance are well represented in plain and ornamental patterns of ornate design or chased metalwork. Amongst these, besides the innumerable bell pushes, are some special pushes for windows and doors, and for burglar alarms, which we do not remember to have seen illustrated in the technical papers before. We therefore show an assortment of these for various purposes. Fig. 1, 2, and 3 are door and window contacts. Fig. 2 has a separate switch for interrupting the current when the alarm is not required to work; Fig. 4 has a trigger contact. Fig. 5 is a blind contact, and Fig 6 is the same with pulley. Fig. 7 has a cord contact for safes, skylights, or such places. Fig. 8 shows a useful form of floor or tread contact for office bell—out of sight and handy.

Passing to telephone instruments, in which this company have a recognised high position, we show in Fig. 9 the new Mix and Genest multiple switchboard, a separate pamphlet upon which can be obtained. In the usual switchboard systems two wires are required for each subscriber, and the construction of the board is of considerable complexity. The switchboard illustrated is of much greater simplicity of construction than that of the Western Electric Company, only one wire being used for each subscriber, and one or two keys being sufficient for 100 subscribers instead of the 40 keys required on the Western Electric system. Testing with the telephone is dispensed with, a galvanometer showing whether the line is engaged or not. The board shown is full—6,000 subscribers with 200 annunciators. It has 5,000 spring-jacks on the upper space, 1,000 general spring-jacks lower, 200 special spring-jacks, 40 pairs of connecting plugs, 40 switches and closing signal annunciators, three galvanometers, and three ringing-keys. The illustration shows the board in operation, with the special form of operator's telephone adopted.

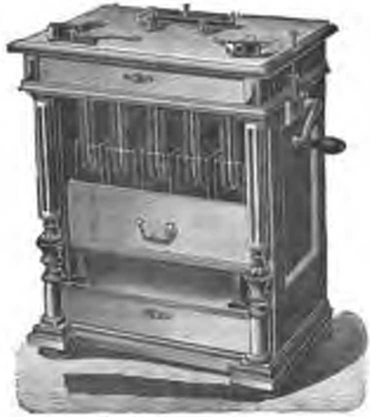


Fig. 17.—Primary Battery.

The Mix and Genest microphones as adopted by the German Government, are shown in their various forms in Figs. 10 to 14. Fig. 10 shows the microphone without induction coil for replacing the Bell-Blake transmitter. Figs. 11 and 12 show the model adopted by the German Government—a microphone with solid walnut mouthpiece and induction coil. Figs. 13 and 14 show the box form of the microphone with induction coil and terminals mounted in side-hinged walnut case.

The spoon-shaped double telephones introduced by this firm, in plain and also in very ornamental patterns, have already been illustrated by us, and are too well known to need further description. We show, Fig. 15, a neat and practical form of telephone station in an airtight case for use in dusty or damp rooms, or in hot and damp climates. The instruments are fitted inside a polished oak case with indiarubber dust-excluding padding and dustproof ball-lock.

A portable micro-telephone specially designed for military, naval, scientific, and mining purposes is shown in Fig. 16. It contains microphone and telephone with switch, induction coil, two dry cells, magneto call and gongs, in oak case furnished with buckle and shoulder straps.

Some very handsome sets of batteries for medical, surgical, or small electric light purposes are among the special features, some with cautery and lamps. We illustrate a form of cupboard of primary batteries, Fig. 17, that may prove useful for several purposes. Small transformers for connection to the main circuits of alternating-current supply stations, which are coming into adoption in hospitals and with medical men, are also made in several forms.

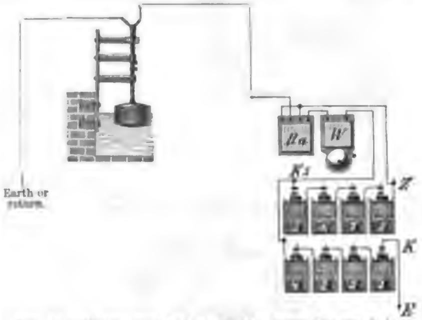


Fig. 18.—Water Level Indicator—Maximum Contact Only.

Perhaps one of the most useful sets of apparatus for public bodies or large factories is the water-level indicator. We show this in two forms. Fig. 18 is a maximum contact water-level indicator, and Fig. 19 is a similar indicator, with indicator for both maximum and minimum contacts, comprising eight cells, two relays and indicators, with two sets of floating globes and contacts. We have not space further than to allude to the batteries, switches, cables, wires, insulators, tools, and various other electrical necessities comprised in the catalogue. In telephone matters the book is particularly rich, and the large number of different patterns of telephone sets for home, office, and public use should, in these days of free telephones, meet with a large and increasing demand.

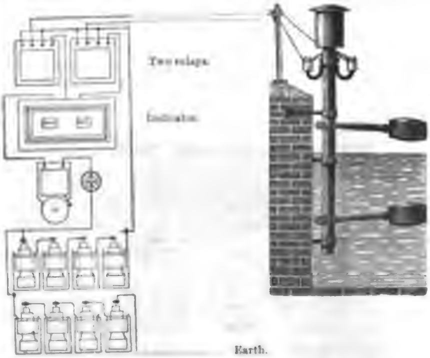


Fig. 19.—Water Level Indicator—Maximum and Minimum Contact.

Bohemia.—The construction of the central station at Arco, in Bohemia, is approaching completion, and the number of subscribers waiting already exceeds the supply.

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CENTRAL STATION MANAGEMENT AND FINANCE.

A short time ago a series of articles bearing the above title, by H. A. Foster, appeared in our American contemporary and namesake. Mention was made of these articles in our columns, and various correspondents made further enquiries with regard to them. A pamphlet based upon this series of articles has reached us, with the imprint of C. C. Shelley, 10 and 12, College-place, New York, who supplies the copyrighted blanks given in the articles. So far as we know, no other systematic attempt has been made to fix a system for the accounts and information of a central office. Factory accounts have been admirably treated on this side by Mr. Garcke and others, but factory accounts differ somewhat from central station accounts. This pamphlet contains some very straight and some very true remarks. Compared with the States, we are numerically far behind with central stations, but it matters little whether the number of such stations be sixteen or sixteen hundred, the necessity for organisation and maintenance upon strict business principles is imperative for success. In his second paragraph Mr. Foster says : "The central station business was so new that very few well-established business men could be persuaded to take hold of its management, and it gradually fell into the hands of younger, untried men, who too often were more prone to experiment with the business than to spend the necessary time in organising it thoroughly on an economical basis. Again, the majority of those placed had not the previous business experience to understand fully the necessity of systematic organisation and strict discipline." There is no single word here but which applies with tenfold force to what has gone on and what is going on in this country. In America, however, the young man means business. He seeks after knowledge with eagerness, and he does not mean to be beaten by any competitors. In England a good many nice young men are trained in the technical schools and technical colleges, are put into the market as experts, not one of whom can tell the general run of wages in various trades, know nothing of prices, of tariffs, of railway rates, of specifications, or of any one of the hundred business points that go to make up a business man. They wonder why, after having spent so much time and money in piling up a certain kind of knowledge—which their teachers honestly believe is the be all and end all of an electrical engineer's requirements—why we say they are shunted for men whose education in many ways is defective. But when matters are more closely examined, it is no wonder that the sprinkling of business men who have got into the profession look upon the man from a standpoint different to that of the teacher. Business men attend to business matters not from motives of philanthropy, but for the purpose of making money. Their assistants are chosen with a view to fitness for this purpose, and there is a decided refusal to accept the services of the greenhorn.

Many failures have undoubtedly been caused because of absence of simple business knowledge. We have always contended that successful companies almost always owe their success to the ability of one man under whose guidance directors—brother directors possibly—and officials are willing to act. The one mind directs, the others carry out details. There is no other road to success. Mr. Foster points out how "knowledge comes" in many cases—for example, not long ago it was thought a day's work to trim forty arc lamps, now the normal number is getting to be 100, some stations piling 120 upon the man. But to do this number properly, the man and the circumstances must be exceptional. Without attempting to follow Mr. Foster into other important matters, we will direct attention to some remarks upon the necessity of regular boiler-room reports. In his opinion this department is one of the most important of all, "as great waste is so easily made if firemen are careless or ignorant. By all means have the best fireman money can hire, as he is the man who shovels away your dollars." Those who would understand the great importance of firing, and the most perfect point to which the art can attain, should attend a Royal Agricultural Society's portable engine competition. Men who witnessed the stoking of Mr. Paxman at the Newcastle competition were amazed at the manner in which the work was done, and although we can expect to see such hardy masters of the art at central stations, we may to see men who understand the business, and not those whose sole recommendation is ability to shovel on coal. Further, Mr. Foster says: "A good chief engineer will find plenty to do to keep the motive-power department up to the best conditions of efficiency. As a general thing, more trouble and waste takes place in this department than in the electrical, and largely from the fact that few station managers understand the advantage of employing a good chief engineer." Not only have we to go to America to get a text for adverse criticism, we can find it nearer home. What, for example, is the general opinion of electrical engineers as to the, if true, damning criticism of Mr. W. H. Booth in the correspondence columns of last week's *Engineer*? Mr. Booth was writing upon another subject, but incidentally he says: "To appreciate fully the real lack of knowledge of the whole subject of boilers and steam production, especially amongst London engineers, one need but glance at the latest examples about London, which will as often as not be found in the electric installations, and compare those with a Lancashire cotton factory's engineering." And more to the same effect. Another correspondent in the same paper, and in the next column to the one just quoted, says: "I know of several fine old examples of engineering skill and architecture being replaced by the ugly, low, scrawling, screaming, and clattering Corliss engines of the present day." Evidently, then, Mr. John Swift's opinions as to the Corliss engines do not agree with those of some electrical engineers. It is singular that a kind of fashionable run has been made, in and around London, on a particular type of boiler. It seems that electrical engineers need some education in these matters, and we doubt if such engineers as Mr. Massey or Mr. Maw would under any circumstances recommend the fashionable type of boiler for central station work. But they really know their business. We have wandered wide from the text of Mr. Foster. The necessity of calling attention to shortcomings is a necessity, though distasteful. Gradually opinion is gaining ground, that we don't want electricians so much as we want electrical engineers. If it were euphonious, the compound word should be engineer-electricians—that is, engineers first, electricians second. Some of our managers on this side might find it advantageous to send for the pamphlet and a few sets of the blanks, which we have referred to in this article.

RIVAL SYSTEMS.

It is, of course, a phase of human nature that every patentee has no eyes for the beauties and advantages of anything not controlled by or in the direction of his own patent. Another phase is that no opportunity is neglected of pushing forward his own production, although such pushing may at the particular moment be detrimental to the prospects of some rival scheme. Thus Mr. F. Wynne, in the *Times* of November 20, discourses—through a long letter, a tiresome historical iteration of patents—against Edison's latest, which might be called the wizard's latest hoax. Of course Mr. Wynne commences with a tirade against accumulators—or, as we prefer to put it, a "self-contained system." This attack is met by the Earl of Albemarle, who points out that if Mr. F. Wynne is "accepted as an authority" his words "might damage others," the others, of course, being the company with which the Earl is connected. The letter of the latter is intended to prove that the self-contained system, instead of being a failure, is a success. But the point made in the reply is that patentees who would pose as authorities often do an incalculable amount of harm. The example given in the letter is as follows:

"The Glasgow Corporation are about to change their system of tramway traction, and although it would not be right to speak positively on a matter still under discussion, I may mention that both in public meetings and in official documents the Glasgow authorities have in unequivocal terms expressed opinions which leave but little doubt that they will adopt the accumulator system. Now, Sir, if Mr. Frank Wynne is to be taken as an authority, those who are negotiating that large and important contract might lose it. There is, therefore, good reason for a protest."

More than once—we can give the occasions if necessary—electrical work has been delayed for years by the untimely interference of quasi-authorities. In this case of electrical traction at the present moment the daily press is doing a vast amount of harm in giving currency to opinions, the correctness of which the managers of such papers are utterly unable to determine. In fact, the best technical authorities are in a somewhat similar position. There can be no sweeping condemnation or approval of channel, overhead, or self-contained system. Each in its proper place has advantages. Mr. Wynne's attack upon accumulators carries to those in the know its own refutation, in that his statements are not in accord with practice, and he argues as if there were only one accumulator to be considered. The *Times* article upon recent practice in Paris, referred to in our last issue, ought to have prevented so sweeping a condemnation. It is no valid argument against the utility of a steam engine to say that if you ask a 20-h.p. engine to work at 200 h.p. it will break down. If, then, business men know what accumulators will do, why should they ask them to work to the point of breaking down? If a horse accidentally falls and is injured, or is otherwise injured, the individual car has to be otherwise assisted. If the company with which the Earl of Albemarle is connected can properly work their accumulators, doing the work as a commercial speculation with a fair profit, of what use is any argument founded on "ifs" and "buts"? The outsider says "No," the insider says "Yes." Whom are we to believe? The one wants to get his system in, the other wants to prevent it. That is a purely business matter, but prevention must not be obtained by misrepresentation.

CORRESPONDENCE.

„ One man's word is no man's word
Justice needs that both be heard."

CHARGING ACCUMULATORS.

SIR,—In your issue of November 13th, in an article on charging accumulators from an alternating-current system, you mention a system which you say was suggested by me.

I should be obliged if you will allow me to state that I remember having had a conversation with a representative of your paper about a system combining storage batteries with alternating-current distribution, of which I am the joint inventor, but it is a very different one to that described by you last week. I quite agree with you that the system described is a great deal too complicated, and I think it would be even less economical than an ordinary alternating-current system working under very bad conditions.—Yours, etc. G. E. B. PRITCHETT.

London, W., Nov. 19, 1891.

MAGNETIC RELUCTANCE.*

BY A. E. KENNELLY.

(Continued from page 473.)

Fig. 5 shows that the minimum reluctivity for soft iron is about 0·15 M.U., while its initial reluctivity is about 3·0 M.U. The critical value of H is also in the neighbourhood of 2. If any critical H can be said to exist for glass hard pianoforte wire it would be in the neighbourhood of 35 units, and every description of hard or impure iron met with in practice not containing much manganese appears to have its critical H between these limits. These reluctivity curves also illustrate perhaps more clearly than any others the leading features of Ewing's theory of magnetisation. There is first the initial stage of diminishing reluctivity during which the imaginary molecular magnets are being deflected from their original configurations, then a short critical range of magnetising force in which nearly all the original groupings are disrupted at the point of lowest reluctance, and finally a steady increase of reluctance as the molecules are gradually forced by increasing magnetic stress into parallelism.

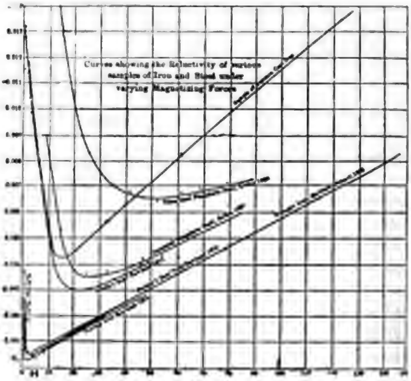
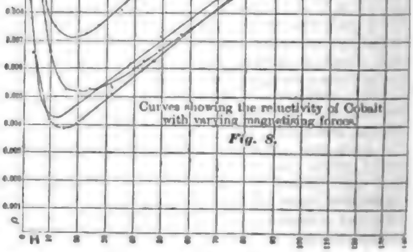


FIG. 5.

This bilinear characteristic curve of reluctivity is not confined only to iron. Fig. 6 shows the same general outlines in the case of nickel, taken from the observations of Rowland and Ewing. Here the initial reluctivities are higher, and the descent to the critical points much sharper than in iron, while the ascending lines are also steep but nearly straight.

Taking the equation $\rho = a + b\text{H}$ in the ascending curve, the first term a only disappears in one known instance—that of nickel under a mechanical stress of 19·8 kilogrammes per square millimetre, or 28,160lb. per square inch—as seen in Fig. 7, taken from Ewing's results. The lowest ascending curve prolonged downwards almost meets the origin. Consequently the flux equation for such nickel would be



Curves showing the reluctivity of Cobalt with varying magnetising forces.

Fig. 8.

$$\text{B} = \frac{\text{H}}{b\,\text{H}} = \frac{1}{b} = \frac{1}{0{\cdot}000177} = 5{,}650$$

and this flux is practically constant for any magnetising force within further considerable limits, representing early

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* Paper read before the American Institute of Electrical Engineers, October 27, 1891.

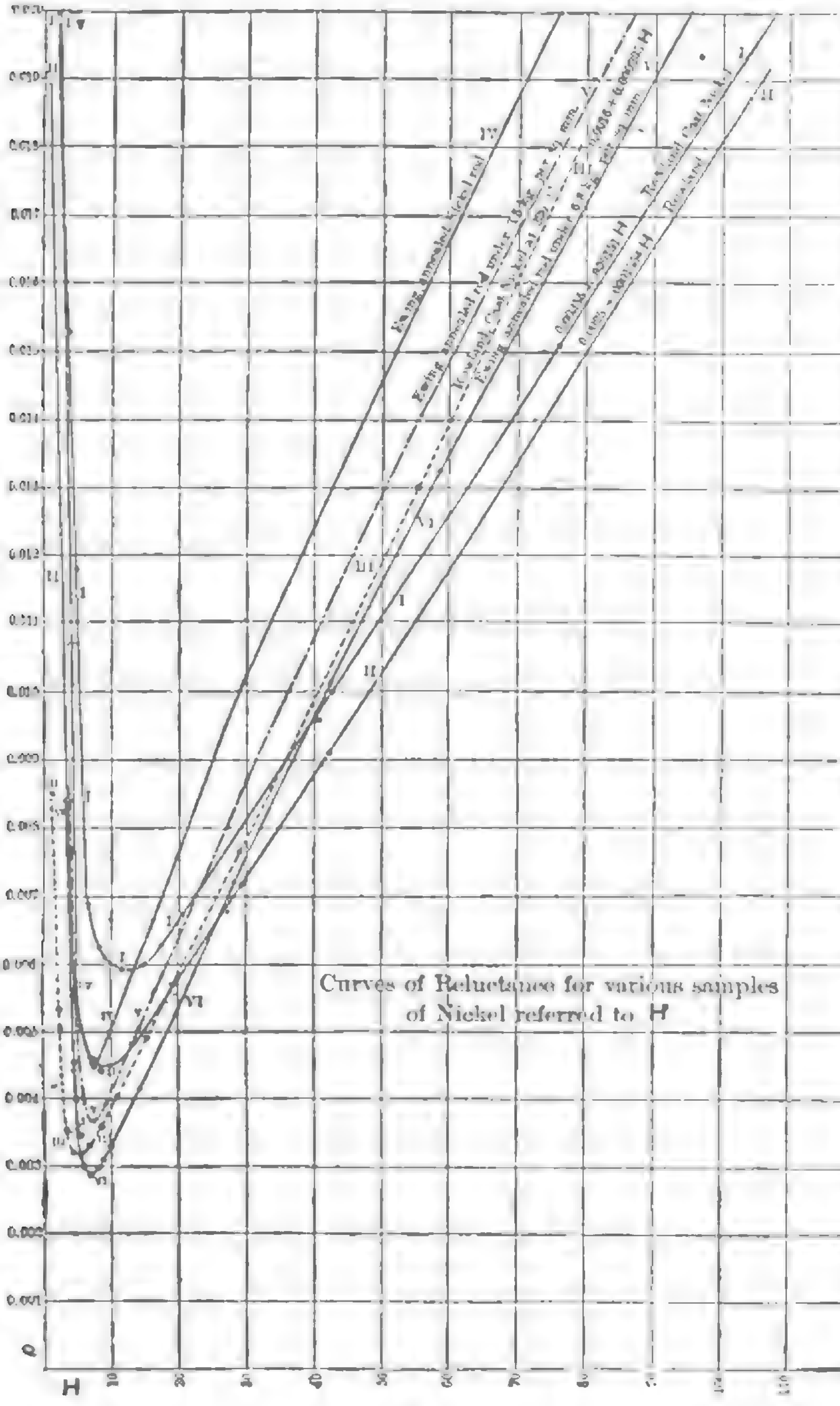

Fig. 6.

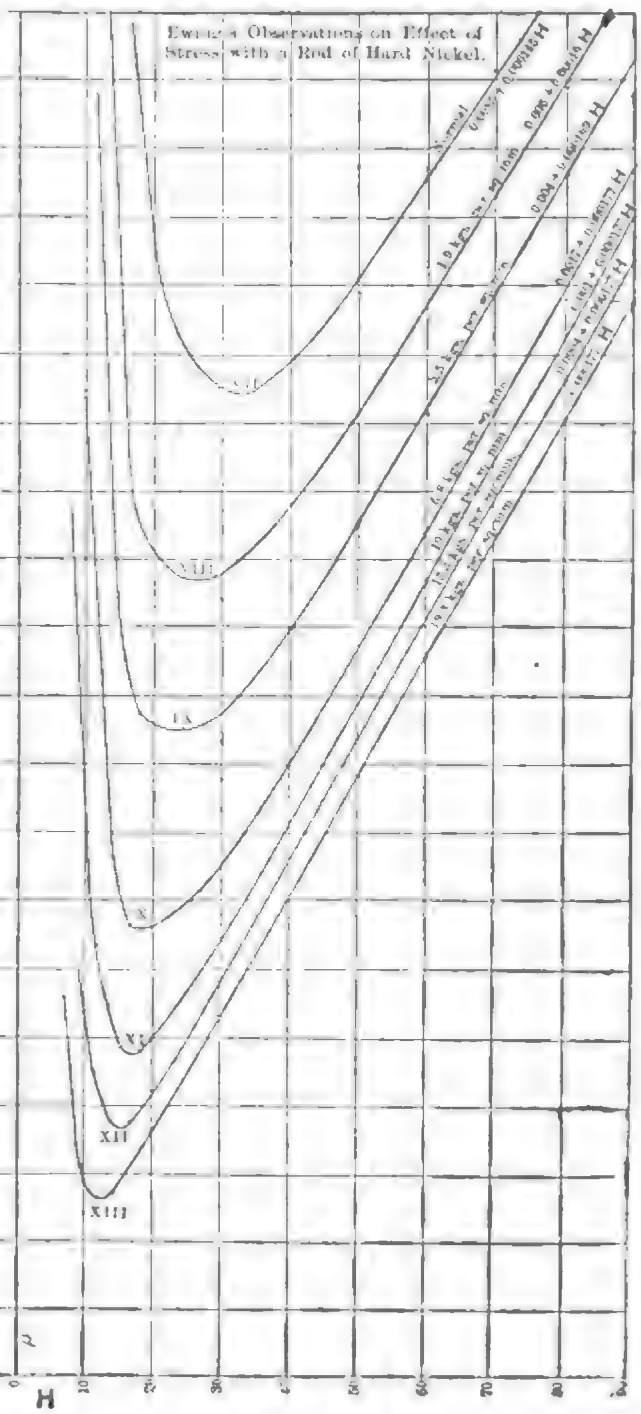

Fig. 7.

saturation. The influence of compression in diminishing the reluctance of nickel is clearly shown in Fig. 7. The critical reluctance is gradually diminished by the stress applied from 14·5 M.U. at H 30 to 2·6 M.U. at H 12.

Fig. 8 gives the corresponding curves for cobalt. The same features are again observable. Only in one case, that of cast cobalt at 230deg. C., is there any considerable deviation from a straight line in either rise or descent from the critical segment of the curve, and this represents a series observed by Rowland under some experimental difficulties, and alluded to as somewhat doubtful.

We have now examined the reluctance of the three magnetic metals collected from all the best-known experimental observations. In addition to these, it appears that every reliable series of tabulated results for iron—pure, impure, cast or forged—exhibits the same types of bilinear reluctance referred to, H, between zero and 150, although in very hard or impure specimens there is no clear indication of a critical point. This assumes, however, that the observations are not vitiated by residual magnetism. For example, the curve obtained by plotting the reluctivities of cast iron, as quoted by Silvanus Thompson from Hopkinson's observations,* differ considerably from this type; but the difference appears to be accounted for by taking the mean between ascending and descending values. The ballistic method of measurement with anchor rings, in which the progress of the magnetising force takes place by extending reversals, gives reluctances that appear to be as nearly linear as those which are obtained by a single increasing amplitude of magnetisation, the influence of hysteresis being apparently nearly uniform in ratio.

(To be continued.)

INSTITUTION OF ELECTRICAL ENGINEERS.

DISCUSSION ON THE DESCRIPTION OF THE STANDARD VOLT AND AMPERE METER USED AT THE FERRY WORKS, THAMES DITTON. By Captain H. R. Sankey, Member, and F. V. Andersen, Associate. *Authorised abstract.*

Mr. Gisbert Kapp said he understood that the platinoid sheets of rheostat A were sometimes used five in series, as in Fig. 2 of the paper, and sometimes five in parallel, and he would like to know how the change was effected without introducing unknown resistances.

Prof. Ayrton said he was glad to see that the authors were supporters of the deflexional method of measuring amperes and volts in preference to the zero method so often adopted. He was particularly interested in the matter, for several years ago one of the authors was strongly opposed to deflexional systems. His conversion he (Prof. Ayrton) considered a great triumph. He was firmly convinced of its superiority, but instead of dwelling on its conveniences would merely refer the meeting to a communication by Prof. Perry and himself which was made to the Physical Society early in 1889, and printed in the *Electrical*

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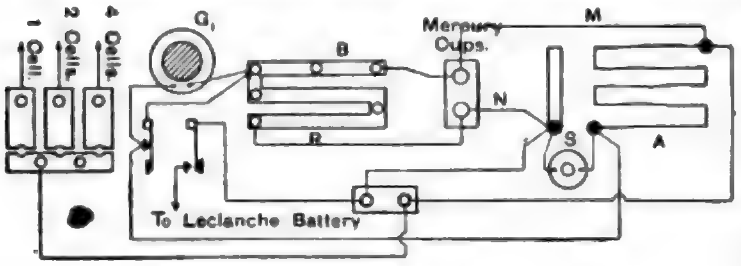
* Silvanus Thompson, "Dynamo Electric Machinery," p. 302.

Engineer for March 1st and March 8th of that year. The many advantages of d'Arsonval galvanometers as standard ammeters and voltmeters were then set forth, and description of standard instruments given. There were several points in the present paper with which he differed. In the first place, he would like to know why galvanometers of comparatively high resistance were used, and why they were wound with copper? For the current measurements, a low-resistance instrument would have been decidedly preferable, and both galvanometers ought to have been wound with platinoid. The ampere-meter would then require no correction for changes of temperature of the room. He enquired whether any special arrangements had been adopted to make the deflections of the galvanometer proportional to the currents. Putting curved pole-pieces on the magnets, and allowing the coil to hang freely from the top suspending wire, would give the desired result. To illustrate the difference in the calibration curves produced by these devices, he showed the calibrations of two originally similar instruments, one of which had been altered, as above described, and the other left untouched. The curve of the former instrument was straight for deflections all across a scale 2ft. 6in. long within 0·15 per cent., whilst in the latter the deviation amounted to about 2 per cent. in the same range.



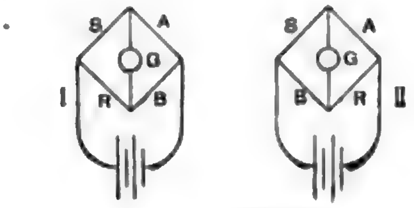


FIG. 2.

Replying to a question from Mr. A. P. Trotter, **Prof. Ayrton** said the scale distance of the proportional galvanometer was 6ft. He thought the authors of the paper had overstated the range of their ampere-meter by giving it as from $\frac{1}{10}$ to 1,100 amperes, for the former current only gave a deflection of about one-thousandth of the length of the scale, and, therefore, could not be measured with any approach to accuracy. Referring to the voltmeter instrument, he enquired whether the error introduced by shunting part of the potentiometer, P (Fig. 4 of paper), by the galvanometer and resistance, R, had been allowed for; in some cases given in Table II. neglecting this would introduce an error of 0·5 per cent. He was of opinion that standard instruments for workshop or factory use should require no constants, and no adjustments of resistances to vary the constant, but that different scales should be used, each graduated to read directly and the resistances altered automatically by the act of changing the scale. Such an arrangement was fitted up three years ago at the Acme Works, six scales being mounted on an hexagonal roller, the turning of which automatically inserted the proper resistance in series with the d'Arsonval galvanometer to make the corresponding scale read amperes or volts direct. Only one scale was visible at one time, so there was no possibility of mistake. Weakening of the magnets was compensated by a magnetic shunt provided with a fine adjustment. Speaking of the change of sensibility of d'Arsonval galvanometers with time, he said that of the two instruments at the Central Institution above referred to, the original form had changed more than 3 per cent. in three years, whilst the modified form had remained perfectly constant since the alterations were made about two years ago. The change of sensibility, he believed, was due to the oxidation of the German silver suspension wires, whilst the other instrument, being suspended with phosphor bronze strip, had remained constant.

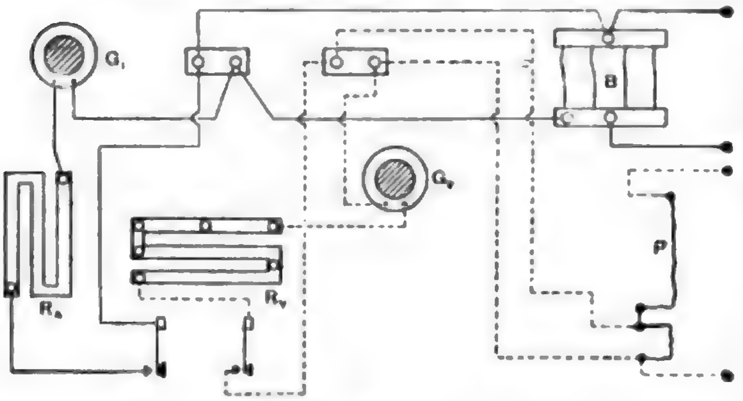


FIG. 4.

CRYSTAL PALACE ELECTRICAL EXHIBITION, 1892.

MEETING AT THE MANSION HOUSE.

A meeting of the Honorary Council of Advice in connection with this exhibition was held at the Mansion House on Wednesday afternoon, under the presidency of the Right Hon. the Lord Mayor (Alderman Evans). Among those present were Prof. W. E. Ayrton, Mr. Shelford Bidwell, Mr. J. I. Courtenay, Mr. R. E. Crompton, Mr. J. E. H. Gordon, Mr. Killingworth Hedges, Prof. D. E. Hughes, the Duke of Marlborough, Mr. W. Massey, Mr. W. H. Preece, and Mr. Alexander Siemens.

The **Chairman** called upon **Mr. George T. Rait**, who said that in the absence of the Hon. D. J. Monson, chairman of the Crystal Palace Company, it devolved upon him as deputy chairman to offer the Lord Mayor their cordial thanks for presiding, and giving them an opportunity of meeting there. He had also to say on behalf of the company how much indebted they were to the committee of the Electrical Section of the London Chamber of Commerce for attending that meeting. It was a very happy augury for the future of the proposed exhibition. He then asked the secretary of the Crystal Palace Company (Mr. William Gardiner) to read the following report of the directors to the honorary council and committee.

REPORT OF DIRECTORS.

The Crystal Palace having been intimately associated with the early introduction in this country of what may be called the modern application of electric force, by means of the electric exhibition of 1881, the directors considered the advisability of holding, when the time should be ripe, a second exhibition in furtherance of the scientific knowledge and industry of this important subject. During the past 10 years enormous strides have been made in electrical engineering, and electricity has formed the subject of legislation in the Electric Lighting Acts of 1882-8; but although much has been achieved, it is highly probable that the great majority of the British public are still unaware of the vast extensions and present developments of this important branch of science. Electric lighting in 1881 was commercially successful only to a limited extent; after years of scientific research, however, experiments have culminated in important inventions, and science has now placed the industry in such a position that electrical engineering is capable of universal adaptation. The machinery of the former exhibition was comparatively small, and the largest units of that period have been greatly exceeded, but what is still more important, economy has so much improved with this increase in size, that an efficiency of 80 per cent. has now been increased to 94 or 96 per cent., thus making the dynamo a highly efficient machine. The forthcoming exhibition will afford a favourable opportunity for conducting test experiments; and it is believed that tests undertaken at the present time by a public body will be of great service both to the scientific world and to the industry at large. The introduction of electrical engineering has very materially affected the construction of engines, so that high-speed machinery, formerly considered of an uneconomical nature, has now developed into a new type of engine, with a speed greatly exceeding that in former use, while the economy is comparable in every respect to that of the older types. The same period of time has afforded opportunities for introducing and perfecting distributing apparatus which, at the time of the first introduction of electric lighting and motive power, was in an imperfect state. The working out of complete systems of culverts and other means of laying cables throughout our streets is a matter which has received most careful attention, and has now been brought to an advanced stage of perfection. The loss through inferior insulation, owing to the unknown conditions by which the supply of towns would be governed, was sufficient to make the early distribution of electricity a subject of doubtful economy. The introduction and perfecting of the transformer system of distributing alternating currents is a matter of immense importance, affording as it does a ready means of applying electricity in an economical manner for the lighting of large areas. A similar advancement in apparatus in connection with house work, as, for instance, incandescent lamps, fittings, switches, fuses, etc., has placed these important parts of a complete system on a thoroughly commercial basis, and economy under each head has been increased. From consideration of the above facts, the directors considered that the present was an opportune moment for once again throwing open the Palace for the purposes of an electrical exhibition, thus affording an opportunity for the public to see the latest advances in electricity. The exhibition of 1881 is recognised as the pioneer of electrical engineering in this country, and it is confidently believed that the exhibition of 1892 will be remembered in history as showing that the infant Electra has grown to years of maturity, and is capable of further aiding science, commerce, and the world at large. The forthcoming exhibition, which will be opened on January 1, 1892, may be conveniently divided into three great divisions, each of which will be subdivided into sections. The first division will represent the modern form of heavy electrical engineering as now used for electric lighting, under which will be shown the latest and most approved machinery for generating powerful currents of electricity. This division will include all kinds of dynamos for continuous and alternating currents, driven by powerful steam and gas engines of latest design, in all aggregating about 1,500 h.p. The second division will be devoted to the utilisation of electric currents other than for lighting, such as the transmission of power, the application of electromotors to railways, lifts, cranes, launches, pumps, fire engines, hauling machines for mines, etc.; also the use of the current for electro-depositing, smelting, welding, and the storage of electricity. The third division will include the generation and utilisation of electric current from primary batteries, in connection with telephony (including switchboards and connections for cities), telegraphy, as used for land and submarine purposes, electricity in therapeutics, and for other purposes. The space available for the above purposes, though large, has been over applied for, and every section of the industry will be well represented. In order to add to the value of the official catalogue of exhibits, the directors have decided to introduce descriptive articles at the commencement of each section. These articles will be written in non-technical language by an electrical engineer of experience, so that the public may be able to understand more fully the meaning of the various exhibits. Invitations will be issued to public bodies throughout the United Kingdom to visit the exhibition, where the various systems of electric lighting will be on view, and in this direction alone very great saving of expense to the authorities will be effected, and other advantages must also accrue. The manner in which the proposal for this exhibition has been received and supported by electrical engineers, the assistance anticipated from the Honorary Council of Advice, from the committee appointed by the London Chamber of Commerce, and from the Institution of Electrical Engineers, all justify the belief that even more interest will be shown in the present effort to popularise electric lighting and electromotive power, than was evinced by the public in the successful exhibition of 1881.

The **Chairman** said they had listened to a very interesting report. He desired to say that he welcomed them there most heartily and most thoroughly, and, in venturing to offer a few remarks, he might at once say that though he could bring no scientific knowledge to bear on the matter before the meeting, he could at all events bring a commercial mind to bear on the subject of electric lighting. He regarded this movement of theirs as very important, and a step in the right direction. It was not a day too soon to enter upon such an exhibition, and he would congratulate them on the step they had taken. Naturally, the chief magistrate of the City of London must be considerably interested in what affected the lighting of that great city. He said, with very great regret, that they in the City were and had been, from various causes, extremely backward in the movement. But he trusted that the past would be corrected almost immediately, and that the light of the future, the electric light, would be adopted in a practical form, and that they would be enjoying the luxury and comfort of it soon. Not only was he interested in the lighting of the City, but, as he would shortly have to come into residence there, he was naturally very desirous to secure the comfort of electric lighting for the Mansion House. The highly interesting report they had listened to said that electric lighting in 1881 (the date of the first Palace Electrical Exhibition) "was commercially successful only to a limited extent; after years of scientific research, however, experiments had culminated in important inventions, and science had now placed the industry in such a position that electrical engineering was capable of universal adaptation." That was very satisfactory, and he took it that the exhibition they would shortly see would go to confirm this statement. The report went on further to state that it was confidently believed that the exhibition of 1892 would be remembered in history as showing that the infant Electra had grown to years of maturity, and was capable of further aiding science, commerce, and the world at large; that the forthcoming exhibition would be opened on January 1st, 1892, and would be divided into three great divisions, each of which would be subdivided into sections. It was also worthy of note that the report spoke of the space available for exhibits, though large, as having been over applied for, and every section of the industry would be well represented. It concluded by saying that descriptive articles would be added to the catalogue, and that these articles would be written in non-technical language by an electrical engineer of experience, so that the public might be able to understand more fully the meaning of the various exhibits. So far as he could judge, they seemed to intend to enter into that exhibition with careful thought and attention, and that it was their desire to make it a thorough success. They had his best wishes, as representing the citizens of London, that it might be a success, and anything that he could do as chief magistrate to assist the movement would be forthcoming on his part most readily and sincerely. He would now call upon Mr. Preece.

Mr. W. H. Preece said he had been asked to bring before the meeting a proposition or a mode of considering the best way of making the forthcoming exhibition of scientific value. During the past 10 years very great progress had been made both scientifically and practically in applying electricity not alone to the purposes of light, which at the present moment was probably, after the Lord Mayor's remarks, in everybody's mind; but also in transmitting speech to distant places, in utilising the waste powers of nature, and in the shape of a new child that was going to perform a very important function in the future—viz., the development of heat in places where the mode of producing it now was most objectionable. In the exhibition they would have most of these things brought before them. In fact, the practical applications of electricity to the wants and purposes of mankind seemed only to be limited by the inventive genius of those engaged in studying this wonderful science, and the limit of the demand for these applications seemed to be the ignorance of the public. It was by educating the public in the knowledge of such applications that exhibitions of this class seemed to do more good than anything else. An exhibition like that at the Crystal Palace took the place very much of an educational establishment, whilst experts had the means through them of studying the progress made by other people here and in other countries. It had been the fashion to call these exhibitions international, and in 1881 that at the Crystal Palace was so called. This word had, however, very much dropped out of fashion. The exhibition at Frankfort was called international, but it really was national. These exhibitions were becoming far more national than international. This one at the Palace would be national, and would afford English engineers an opportunity of comparing progress without the deterrent effects of foreign tariffs. They had to show as far as possible the developments of electricity. They had also to show the efficiency which had been secured. But they had, more than all this, to bring forcibly before the scientific and commercial world the economy that been attained in electric lighting. They, who had so often to speak of the relative merits of gas and electricity, frequently had their statements doubted, because they were unsupported by the opinion of those who were actual users of electric light. When he said there that electric light was now as cheap as gas, many in that room would doubt his statement. If they did doubt it, they had simply to ask their friends who had adopted electric light, and to compare their out-of-pocket expenses for electric lighting with the same expenses for gas, and they would find the difference between the two to be practically *nil*. Now, it was sufficient to say that electric light introduced no danger, no noise; that it filled a room with brilliant rays of light practically without heat, that there was no smoke or dirt from it, and no vitiation of the air (users breathed pure air), and that there was no destruction of book bindings. In bringing these matters before the public, the proposed exhibition was going to perform a very important function indeed. The object was a sanitary one, and they could not too strongly enforce upon the Lord Mayor and the City authorities the fact, that it really was a movement as great as that for the purification of water which they had before them when they endeavoured to force electric light upon their constituents. To speak more of the scientific side of the question, they wanted to see how far practice had kept pace with science at the forthcoming exhibition. The report spoke of certain test experiments being made with exhibits at the exhibition and their value. He should propose the appointment of an expert committee of 12 gentlemen, whose duty it would be to perform very much the function of the juries in former exhibitions. It was not intended to form a series of juries to go through the various exhibits and allot medals. What the prize was to be he did not know, but what they had to do now was to see that the efforts of English engineers complied with the requirements of science, that their apparatus was the most efficient and economical that could be produced. For that purpose they wanted test-rooms well equipped with apparatus, and a committee to carry out these tests who should be above suspicion, and as to whose ability to carry out the work there should be no doubt. With that object he had been asked to propose that a committee be formed, consisting of: Prof. W. Grylls Adams, D.Sc., F.R.S.; Prof. W. E. Ayrton, F.R.S.; Major P. Cardew, R.E.; Prof. W. Crookes, F.R.S.; Sir James N. Douglass, F.R.S.; W. B. Esson, Esq.; Prof. D. E. Hughes, F.R.S.; Gisbert Kapp, Esq.; Prof. A. B. W. Kennedy, F.R.S.; W. H. Preece, Esq., F.R.S.; Prof. J. Perry, D.Sc., F.R.S., and Prof. Silvanus Thompson, D.Sc., F.R.S. His proposition was that these gentlemen should be formed into such a committee to carry out the object referred to.

The **Duke of Marlborough**, in speaking to the proposition, said there was no doubt that this was a very important epoch in electric lighting. They were within view of the development of a great industry, which in its time would take as high a position as gas had done in former times for the same purpose. No doubt the formation of the proposed committee would give to the forthcoming exhibition an instructive character which would be valuable. By its means they would afterwards learn what were the results given by the machines, and what their product and efficiency was. He would not go so far as Mr. Preece in saying that they could produce the electric light at the same price as gas, but he would say that the time was rapidly arriving when they would do so. If they could erect a centre of energy of sufficient size to be able to light a large area, no doubt the primary cost of producing that energy would be very much lessened, and therefore they might expect when they had stations, not with 30,000, but several hundred thousand lights, that the cost would be very largely reduced. Therefore he was quite sure electric light companies were going to make very substantial profits on their undertakings. Since the exhibition of 1881 they had made enormous strides in the production of electrical energy, and they owed a debt of gratitude to the gentlemen who had worked out the problems thereof in their laboratories. They could now give commercial men certain data which they could take with confidence, and on which they could build. They could ask the public to subscribe to these undertakings with a feeling of complete confidence that the result would be satisfactory to those who invested money in them. The City had taken the lead in encouraging the electric lighting industry, and it was now interested in probably one of the greatest problems which had ever been started. It had not only given a franchise to a public company for the private lighting of offices and houses, but had been public-spirited enough to put the street lighting in their hands also. He hoped the company would have the pleasure of making its first start in private lighting with the Mansion House. There was a great deal of work to be done before the streets could be properly lighted, owing to the difficulty of finding room for the cables beneath them. The lighting would be a matter of time, and he proceeded to argue that if the public and the City authorities (the Commissioners of Sewers had been indulgent) would not hurry the company, the chances of the work being an entire success in the end would be greater. As to the committee to be appointed in connection with the exhibition, he would suggest that in the case of any exhibit too late for entry which might have some interesting and novel feature, it might be allowed to be added afterwards, either with the right to compete for honours or without, as they might advise.

The **Chairman** put the proposition to the meeting, and it was carried *nem. dis.*

Mr. Rait said that, on behalf of the Crystal Palace Company and on behalf of everyone there, he begged to thank the Lord Mayor most cordially for presiding. He hoped the exhibition might be opened on the 1st January, and also that the Lord Mayor would then honour them with his presence. The company would do all in its power to make it a success in every way, and with this committee of experts success seemed assured. The Palace Company was indebted to the City of London; their interests were closely allied, and would as time went on become still more so.

The **Chairman**, replying, said it afforded him very great pleasure to see them there, and he would do all in his power to further the movement. He would certainly do himself the pleasure of attending the opening of the exhibition.

Colonel Gouraud added a word or two based upon the experience of the 1881 exhibition and addressed to exhibitors, to the effect that they should spend freely at the forthcoming exhibition, because those who had succeeded at exhibitions had been those who had spent their money most freely.

The meeting then separated.

COMPANIES' MEETINGS.

SWAN UNITED ELECTRIC LIGHT COMPANY.

The ninth ordinary general meeting of this Company was held at the Cannon-street Hotel on Tuesday, Mr. James Staats Forbes, chairman, presiding.

The **Chairman** said: Gentlemen, the report and accounts have been printed and circulated. I suppose we can take them as being read. If that is your pleasure I will, in the ordinary course of things, proceed to make a few remarks upon them, and probably the most convenient method is to deal with the figures first before entering upon more general questions. The material thing in these yearly accounts is to ascertain the result of the year's working. That will be found in the profit and loss account, which, in fact, is the trading account for the year. It is very short, very simple, and very easily comprehended. If you will kindly follow me through the debtor side of the account, and then through the creditor side, I think you will be able to appreciate very clearly the position of the undertaking as a going concern for the past year. The first entry is "Stock, October 1st, 1890, brought forward £11,124." Then comes "Purchases," which means the material, and in some cases the finished article necessary to carry on our business. Then come the costs of the general administration of the Company—salaries, Directors' fees, rent, office expenses, income tax, general and law charges. Then wages and expenses at the factory—that is, over and above the mere cost of materials purchased. It is the cost of turning these materials into a saleable commodity. Then there is depreciation, a small amount written down as ledger reserve against the possibility of bad debts, and then comes the balance. On the other side of the account is our business, "Sales, less commissions and allowances," £15,348; "Interest and transfer fees," £1,290; "Dividend on the shares of the Compagnie Générale in France," £1,178; "Dividends on shares in the Edison-Swan Company, Limited," £34,799; and the stock with which we closed up the year, the stock on hand of materials and lamps, £18,449. Dealing with the credit side of the account as presenting what may be called a solid asset, and dealing with the other side of the account as representing the cost of that asset, you will see what the balance is—viz., £39,038. Now, of course, you will observe at once that a very large part of the profit—that balance of £39,038 representing profit—is derived from the investment of your money in the Edison-Swan United Electric Light Company—£34,799 out of the £39,038 of balance. I think I have said enough about that until I come to some details which I shall have to deal with presently. I will now take you down to the balance-sheet. There you see the state of the share capital, which consists of two classes of shares, upon which different amounts have been paid—£5 in the case of the fully-paid, and £3. 10s. in the case of the partially-paid shares. The total capital is shown as amounting to £375,071. We have forfeited shares put at £3,530, that being the amount paid upon allotment and upon some proportion of the calls by people who later on failed to pay up the calls when made; and these shares we forfeited in due course and after proper notice to the parties, and they are, for what they are worth, an asset of the Company. "Sundry creditors," stands at £4,642; "Balance from previous account" at £8,451—because last year we did not divide up to the hilt, but paid a certain dividend and carried forward this amount; "Balance brought down from the profit and loss account above," £39,038, making the sum available for distribution £47,490. In this, as in other companies who have an annual balance-sheet and an annual distribution, when they are upon their feet and treading on something like solid ground, it is becoming the fashion to pay what is called an interim dividend. We have done it now for a year or two, and this year we paid, on May 21, £11,104 on account of the year's dividend. That amount deducted from £47,490 leaves £36,386 to be dealt with to-day. On the other side of the account you get a very simple statement of the position of the Company. You will see that "By cost of patent rights represented by shares in Edison and Swan Company, shares in the Compagnie Générale, patents held by the Company for Germany as per last balance-sheet" is written down at £330,837, and if you cast your eye across the page you will see that the paid-up capital of the Company is £375,071. Assuming that £330,837 to represent the value at which it stands, there are some other assets. By the bye, I see "Additional expenditure thereon—subject to readjustment between the companies," £1,612, that will make the figure £332,449. "Outlay on factories, plant, etc., as per account, less depreciation," stands at £1,570, but I need hardly say that the actual outlay has much exceeded that amount, because you cannot establish a factory calculated to turn out any considerable number of lamps for anything like £1,500. The reason that amount is so low is that for some years we have written off 20 per cent. out of revenue on account of money expended in that way. "Sundry debtors," £6,545, exceeds the corresponding item of "Sundry creditors" on the other side of the account by nearly £2,000. "Stock on hand" stands at £18,449, brought down from profit and loss account. "Investments in Prussian Consols" is £5,120; "Investments in 2¾ per cents.," £29,004, and "Cash on deposit and in hand," £26,490 Now, first of all, what are you going to do with this £36,386. 10s. 9d.? What the Directors would recommend you to do they have set forth in the report. They recite what the credit balance is; they tell you that out of that balance they have already paid you £11,104, and they recommend that the dividend on the year should be at the rate of 11 per cent., which will leave £28,376. 6s. 11d. to be paid, and will also leave £8,010 to be carried forward for the benefit of the current year, which you will see is within £450 of the amount we brought forward into the year. That seems a recommendation entirely justified by the state of the balance-sheet, and I think you will agree that in the position of the Company it is prudent not to divide up to the hilt, and therefore if the year's business has resulted in this—that you can pay 11 per cent. and carry forward about the same balance as last year—it is not so very bad, particularly when you come to deal with one of the unrealised items of the profit and loss account, and that is the stock on September 30, 1891, £18,449. I have had occasion to explain this item before, and perhaps I had better do so again, because these meetings are only held once a year, and in the course of a year we know by our transfer lists that the proprietors change, and some, at all events, of them, cease to be familiar either with the details or the principles upon which this business has to be conducted. It is perfectly certain that these lamp companies cannot conduct their business satisfactorily without having in hand a very large amount of stock. The lamps—although they are generally described as 16 c.p., or 8 c.p., or some other denominative quantity—are, in fact, greatly varied in many particulars. And outside what you may call the regular business, there are a great number of lamps made to special order which involve a great many diverse types, and a great many subdivisions of stock. This is a disadvantage in one sense, but an advantage in another. A great business cannot be done without a great stock, and a great stock means a large amount of money locked up—you will see £18,449 in this account. That, by the bye, may turn out to be an advantage to these big companies. Having had a start for a term of years, having made a reputation, having made a *clientèle*, and being able to turn out a large amount of lamps, they can do so at a price at which a small man could not possibly live. That stock of 18,000 and odd pounds is made up very largely of lamps, in round numbers about £13,000 of it, and those lamps are brought into stock at cost price. If we were met to-day to say "we have come to the end of our business," we could ask, "What is that stock worth?" "How many of those lamps are saleable, and at what price?" Well, if you have credited the account with the actual cost, and you realise a moderate profit on sales—which is, of course, what you would do—you would have all that to the good. Therefore what you are dealing with now is a (humanly speaking) absolutely safe profit of 11 per cent., with £8,000 carried forward from the previous year, and a contingent value lying dormant in your concern for realisation in the current and future years—that is the position of the whole thing. I don't propose to go into any details of the various figures except in answer to questions, and I would take the liberty of inviting any questions and criticisms that any honourable proprietor may think it necessary to address to me as representing the Board. We desire it. Now to come to something a little more general. The most satisfactory part of this report is the paragraph which tells you that the decision of the Supreme Court at Leipzic in the patent case with certain companies—that very long case brought against this Company and their agents—has now been given in favour of the Company. That is a matter of great moment. The question in dispute was exactly the same as was in dispute in England, when the wisdom of, I think, some of the gentlemen sitting at this table, induced the Edison Company and the Swan to put their horses together, instead of cutting each other's throats. Oddly enough, in Germany, the Edison Company, or those representing it, and those representing the Swan Company, have not been able to follow so wise an example, with the result that they have now been in litigation for several years, the Swan Company having been brought to book by the Edison as infringers of the latter's patents. We never raised that question in this country. It is not for want of trying on our part that that state of things has existed in Germany. We have tried to persuade our friends there that what has turned out so good in England might be good in Germany, but hitherto they have not seen it. The result is that we have now been declared successful in the final appeal—after protracted legal proceedings which will equal anything we know in the law courts of England as illustrating the law's delays. That is to say, the

Swan lamp as we manufacture it has been declared to be no infringement of the Edison patents, and we are free now to go our way without challenge, without being denounced in advertisements and conversations as infringers, without our customers being threatened with proceedings, and without we ourselves being threatened with damages in the event of our being found guilty of infringement. That places the German business in an entirely different position to what it was in before. As the Directors say in the report, "We are now engaged in the consideration of the best way to take advantage of the favourable position thus created in Germany." It is the difference between working in freedom and working in chains, and although the nature of the German law is that the penalties upon people who are wrong-doers in the dark, as it were, and without knowledge, are generally very light, when they have been warned that they were doing wrong by legal notice, if they continue so to do, they stand to be pretty heavily salted. And that is our position, because this litigation began several years ago, and although we went on making Swan lamps, we had always before us the fear of penal damages. During the last year or two we have learned a little by litigation, yet we were fearful that some abstruse points might turn against us, so we held our hands, and did not push our business as we think it might have been pushed, and as we probably shall push it now. Then the next paragraph in the report is about our little investment in Paris. There the same conflict is going on as to these patents, and about the time they run out some decision will be come to. That is about the English of the business. The company there is not doing very well because they are in litigation, and during that litigation everybody can make lamps, and there is a cutting of rates going on. It is very probable and possible that that state of things may terminate sooner or later. The French companies, I suppose, will come to some sort of understanding, because there is no particular object in men giving their brains and their money to manufacture things and sell them at a price that leaves no profit. It may go on for a short time, but it is bound to find its cure, even with fools. That brings me to the end of the report, but I would make this observation. The Swan Company, you see, have now got into a peculiar position. We have divested ourselves of any care or trouble about the working of our British patents, and we did that in virtue of £208,478 shares, or capital rather, held in the Edison-Swan United Company. I don't know whether honourable proprietors appreciate that that Company is doing very well, that in all probability it may, in the future at all events, be tolerably well off. Like other companies, they have got to face the different state of things which will arise when the protected period runs out. That we have foreseen. We have laid our plans and established our policy upon this, that we must make hay while the sun shines. That is to say, we must make the best lamps, we must get the largest *clientèle*, and establish the best reputation, and at the end of that time, with ample means and good connections, we must take our chance with other people. If that policy is justified by the result, we shall find ourselves in a position to make as good a lamp as can be made, probably better than most lamps. We shall find ourselves in possession of a great many customers who will not easily be tempted to change. With the capital we have in hand we shall be enabled to produce these lamps at a price as low or lower than other people can, and therefore shall be enabled to sell at a low price with a profit. In fact, it will then mean a small profit on a large quantity, instead of a large profit on a small quantity. And you will participate in that pudding to the extent of £208,478. You are the largest shareholders in the united company. We parted with our business in France for £30,489, and they have got to make a fight for it. But they are very powerful people. The French are not as methodical and business-like as we are. They are more scientific and more logical, but not so practical. They will, I daresay, be able to take care of themselves; at all events, I hope so. Then the only other thing is this German business, and this may be a more or less important factor, according to the future. In proportion to its magnitude it was an exceedingly troublesome and difficult matter. Now that is settled, and therefore it is just worthy of consideration whether it is worth while for the purpose of administering that portion of the business, all the other part being administered for us either by the Edison-Swan or the French Company—whether it is worth while keeping up a separate company and machinery for that purpose. You know what we said before, that when the litigation was over it would be prudent to consider whether the Edison-Swan Company in England might not absorb upon fair terms the outlying business and assets generally of the Swan Company. They have a considerable amount of money and other things in hand which could be utilised by the Edison-Swan Company just as well as by the Swan as a separate administration. Of course there is no possibility of entering into details about the matter now. The Edison-Swan and the Swan Company are a united body, but though united they consist of two parts, and although in Britain they have absolute identity of business, in a question of buying and selling a new business they might not. We have on our Board gentlemen imported into the happy family from the Edison Company who are largely interested in it, and they represent themselves and their co-partners in the Edison Company. And we have gentlemen connected with our Board who hold largely for themselves and represent largely the interests of the Swan Company, and we have thought it well, in order that we might be prepared at some early date to consult the proprietors on details, to ask two of these gentlemen on either side to meet and consider the question of fusing the Swan Company, or rather taking over the assets and outstanding business of the Swan Company not already provided for, upon some terms that will be acceptable to the proprietors of both companies. It is in good hands, and now the litigation is over in Germany it should not take long to come to some conclusion. We honestly think that the time has gone by when it is necessary to carry on the Swan Company as a separate concern merely for the sake of conducting the German business. On the other hand, the Swan Company must consider that the German business may turn out very valuable and worth conducting. The only question is whether it is worth while to keep up the Board to conduct a small business when it might be done by our partners, the Edison-Swan Company. I hope that principle may commend itself to proprietors. I will now move that the report and accounts for the year ending 30th September, 1891, be received and adopted.

This was seconded by **Mr. F. R. Leyland.**

In reply to a shareholder, the **Chairman** said that their patents had nearly three years to run in Britain. As to the German litigation, all that had been determined was that the Swan patent was not an infringement of the Edison. They had never got so far yet as to establish the Swan patent as a patent, and he did not suppose they ever would. He then put the motion, which was carried unanimously.

The **Chairman** then proposed the declaration of the 11 per cent. dividend (inclusive of the interim dividend already distributed), explaining the somewhat complex manner in which it worked out per share as between partly-paid and fully-paid shares. The figures for the ordinary part-paid shares are 5s. 7¼d. per share, and for the fully-paid shares 6s. 4¼d. per share.

This was seconded by **Mr. F. R. Leyland**, and carried unanimously.

The **Chairman** said the next business was the re-election of the retiring director, Mr. J. W. Swan, whose name was so well known, and whose services to the Company had been very considerable. He had so identified his name with the Swan Company that it seemed almost a matter of course that he should be re-elected, apart from considerations of fitness and a large holding in the Company, and as everyone knew great inventive as well as great business capacity. He would like the proposition to come from the body of the meeting rather than from the Board.

Mr. J. C. Stevenson, M.P., as one who had been connected with Mr. Swan as chairman of the Newcastle Board, and had dealt with the matter of his lamp from the first, begged to propose his re-election as director.

Mr. Arthur Tooth seconded, and it was carried unanimously.

Mr. Swan thanked the meeting.

The auditors, Messrs. Welton, Jones, and Co., having been re-elected, a unanimous vote of thanks was accorded to the Chairman, who, in reply, said that perhaps it was not assuming too much to say that if they had had less heart or less brain, and if they had not had the essential condition of success, together with the support of those whom they represented, they would not have overcome their difficulties so successfully.

TIVERTON.

The following is the text of the Borough Surveyor's report to the Council:

To the Electric Lighting Committee of the Town Council.

Gentlemen,—In presenting to you my second report on the subject of electric lighting, I have considered it advisable for the sake of convenience to incorporate the substance of my first report, dated December 1st, 1890. I have obtained information on the subject of electric lighting from various towns in Great Britain, which I have arranged in a tabulated form, and in accordance with your instructions have visited various electric lighting stations in London and other towns, and observations on the different systems employed will be found in the report.

PROGRESS OF ELECTRIC LIGHTING.

Public electric lighting, while it has made enormous progress in America and other parts of the world, has been a movement of slow growth in Great Britain. No doubt the reasons for this are the great amount of vested interests it has to contend with from the fact of so many of the gas lighting undertakings being in the hands of corporations and of local companies; and also on account of the severe regulations of the Board of Trade and Acts of Parliament, which were promptly passed for the protection of the various interests involved, and of those working and using electricity for public and private purposes.

This delay has, however, had its advantages: it has allowed the systems employed to pass through the experimental stages and their comparative merits to be more accurately determined; it has given time for the apparatus employed to reach a high stage of development and to be improved both in the direction of efficiency and economy; and has given an opportunity for those now about to engage in electric lighting enterprises to work upon the experience gained by others; and I feel bound to state in regard to the latter point that I have had every facility placed in my way by officials of companies and electrical engineers in my enquiries in regard to the various systems now in use.

There are at present but few towns in Great Britain that are lighted by electricity. They are Taunton, Barnet, Waterford, Leamington, Bath, Bacup, Barnsley, Cambridge, Fareham, Lynton, and Lynmouth, Weybridge, and some districts in London. Portions of the following towns are also lit by electricity: Chelmsford, Eastbourne, Galway, Blackpool, Greenock, and Newcastle-on-Tyne. In the following towns there are central stations successfully carried on for the purpose of private lighting (most of

SANITARY DISTRICT.				GAS LIGHTING.													
CITY OR TOWN.	Borough or local board.	Population of sanitary district.	Area of sanitary district.	Area of lighting district.	Length of streets in lighting district.	Is the gas undertaking the property of the authority?	Price of gas per 1,000 feet.	Cost of lamp burning feet per hour per annum.				Cost of gas lighting per annum, before lighting by electricity.			Area of lighting district.	Lengths of streets in lighting district.	Under what arrangement is the lighting carried out.
			Acres.	Acres.	Miles.			Ft.	£	s.	d.	£	s.	d.	Acres.	Miles.	
BACUP	B	25,033	6,400	3,500	57	No	3/7	4½	2	1	10	1,423	16	0	20	3	Co. put do plant, Corp tion work a
BARNSLEY	B	35,000	2,400	200	6	No	3/4	4	2	8	0	1,800	0	0	200	6	Corporati
CAMBRIDGE	B	41,070	3,278	3,278	33	No	2/10	4½	2	17	9	2,932	17	6	3,278	33	Compan
LONDON (City)	—	—	—	—	—	—	—		—			—			—	--	Companie
BARNET	L.B.	4,095	245	245	—	—	—	—	2	18	0	—			—	—	Contract to Sept., 1
BATH	C	51,835	3,745	3,745	50	No	2/8	4	2	12	6	5,600	0	0	Centreof city only	5	Contract 7 y
FAREHAM	L.B.	7,171	29,000	—	6½	No	3/9	4	4	0	0	500	0	0	—	6½	Contract 3 y
LEAMINGTON	B	—	—	—	—	—	2/6		—			—			Parade.	½	Compan
TAUNTON	B	20,000	1,200	—	—	No	4/- less dis.	5	2	15	0	765	0	0	—	3	Compan
WATERFORD	C	23,000	532	532	15	No	5/6 less15p.c.	4	3	16	0	1,612	0	0	150	4	Contrac
WEYBRIDGE	—	—	—	—	—	—	—		—			—			—	6½	Contract 5 y
CHELMSFORD	B	12,000	—	—	13	No	4/-	187 burners for 3,410 hours.				—			—	1,000 yds.	Contract 5 y
EASTBOURNE	B	30,000	5,506	890	30	No	3/2	5	4	4	6	—			Parades.	1,600 yds.	Compan
GALWAY	B	19,171	4,480	—	18	No	4/9		—			400	0	0	Harbour only.	—	Compan
GREENOCK	—	—	—	—	—	—	—		—			—			—	—	Corporati
NEWCASTLE	B	163,000	5,371	—	155	No	2/1less10 p.c.	5	2	12	0	—			5,371	155	2 compani
BOURNEMOUTH	B	35,000	5,506	—	55	No	—		—			—			—	—	Compan
BRIGHTON	B	107,546	—	—	—	No	—		—			—			—	—	Compan Corporati
BRADFORD	B	240,515	10,776	—	—	Yes	2/3	4½	2	10	0	—			—	—	Corporati
HASTINGS	B	42,258	—	—	—	—	—		—			—				—	Compan
CARDIFF	B	82,761	—	—	—	—	—		—			—			—	—	—
EXETER	C	37,665	—	—	—	—	3/-	5	3	13	0	—			—	—	Compan
EDINBURGH	C	—	—	—	—	—	—		—			—			—	—	Ry. compe
KESWICK	L.B.	3,500	728	367	4	No	4/- lighting 3/3 cooking	—	1	13	6	—			—	—	Contrac
OKEHAMPTON	B	1,695	—	—	—	—	—		—			—			—	—	—
SHEFFIELD	B	332,837	19,651	—	—	No	2/2		—			—			—	—	—
ST. AUSTELL	L.B.	4,520	—	120	4	No	5/-	5½	1	9	3	110	0	0	—	—	—
LIVERPOOL	C	613,463	5,210	5,210	276	No	2/8	4	2	17	11	35,410	7	8	—	—	Company
THETFORD	B	4,520	—	1 sq.mile	—	No	5/-					180	0	0	—	—	Company
BIRMINGHAM	C	462,000	8,420	8,420	200	Yes	2/3 to 2/7	5	1	14	5	12,000	0	0	—	—	Company
NORWICH	B	100,000	7,000	—	—	No	—		—			—			—	—	—
NORTHAMPTON	B	60,000	1,520	500	30	No	3/1	5	2	5	3	—			—	—	—
READING	B	62,000	5,861	5,861	—	No	—		—			—			—	—	Contract 7
SOUTHAMPTON	B	60,051	—	—	—	—	—		—			—			—	—	—
DARLINGTON	B	40,000	3,909	3,909	—	Yes	2/2	5 Bray's	2 80 c.p.	15	6	2,300	0	0	—	—	
FOLKESTONE	B	22,000	2,481	2,481	26	No	3/3	4 ”	2 ”	16	0	—			—	—	
OXFORD	C	53,000	4,650	4,650	48	No	2/4 to 2/6	4	2	10	0	2,400	0	0	—	—	ELECT
SWANSEA	B	96,282	5,963	—	50	No	2/10 to 3/-	4	2	16	1	—			85	4	YET
SCARBOROUGH	B	35,500	2,292	—	35	No	2/8 to 3/3	4½	2	15	10	—			—	—	
WIMBLEDON	L.B.	28,000	3,225	2,000	29	No	3/10	4	3	10	0	—			—	—	

which are suitably equipped for public lighting also): Bournemouth, Brighton, Bradford, Hastings, Cardiff, Exeter, Edinburgh, Keswick, Okehampton, Sheffield, Woking, and St. Austell; and companies are commencing operations in Norwich, Northampton, Reading, Southampton, Dublin, and Glasgow. In the following towns the corporations work the system themselves: Bacup, Blackpool, Barnsley, Dublin, Greenock, Glasgow, and Bradford, and it is worked by companies in London, Barnet, Bath, Taunton, Waterford, Weybridge, Woking, Chelmsford, Eastbourne, Galway, Newcastle, Bournemouth, Hastings, Exeter, Edinburgh, Keswick, Okehampton, St. Austell, Birmingham, and Reading.

The progress the electric light has already made has conclusively demonstrated its applicability for public and private lighting, and improvements of machinery and apparatus are continually taking place, tending to enhance its efficiency and reduce the cost of production.

SYSTEMS.

The systems employed are various applications of the following:

1. Low-tension, direct-current, three-wire system.
2. High-tension, direct-current, charging accumulators in storage batteries.
3. High-tension, alternating-current, with transformers for incandescent lighting to reduce the current to low voltage for safe consumption.

Each system has its advantanges and disadvantages.

ELECTRIC LIGHTING.

	System of Lighting.	Arc lamps.			Incandescent lamps.			Underground or overhead wires.	Cost of lighting the streets compared with gas.	Price to private consumers.	Observations.
		No.	C.P.	Per hr.	No.	C.P.	Per hr.				
	Continuous low-pressure three-wire	6	1,000	—	1,500 50	16 20	— —	Underground	—	6d. per unit	—
	High-tension alternating-current	50	1,200	—	4,000 190	16 32	— —	Overhead	Estimated £600 per year more than gas for the limited area	6d. per unit	—
	Continuous, also alternating-current	—			—			—	—	8d. per unit	—
Co. Co.	Brush series and transformers Thomson-Houston		2,000	1¼d.		28 56	0·3d. 0·6d.	Underground	—	8d. per unit	—
	—		—		6 71	15 32	per ann. 2 14 0 5 8 0	Overhead	—	—	—
ham	Streets: Thomson-Houston	81	1,200	per ann. 25 7 6	None		—	Underground	£724 more than gas	—	—
.C.	Private: Brush, alternating Thomson-Houston	21	1,200	—	85	20	—	Both	About the same	6d. per unit 1/- per c.p. per annum	—
	—		None		193	16	—	Underground	Double light, 2½ times greater	—	—
.C.	Thomson-Houston	29	1,200	per ann. 22 10 0 1¼d.	1	36	per ann. 5 0 0	Overhead	Double, but so much more light	1/- per c.p. per annum.	—
n Co.	Thomson-Houston	34	1,200	per ann. 22 0 0 1·6d.	—			Overhead	About the same	8d. per unit	—
n Co.	Thomson-Houston		—		112 1	20 200	ann. 2 5 0	Overhead	Never lighted by gas	9d. per unit	—
Co.	Direct-current arcs and transformers	19	2,000	per ann. 22 10 0 —	212 2	32 50	ann. 2 6 10	Overhead	Nearly same, but have better light	1/- ; to be reduced to 10d.	A
.L.C.	Brush	16	1,000	per ann. 35 0 0 3½d	—			Underground	E. L. £652, gas £220	10d. per unit.	—
.C.	Low-pressure	2	1,200	¾d.	16	8	0·12d.	Overhead	E. L. £200, gas £400	5d. per unit	—
	Anglo-American Brush		None		25	20	per ann. 3 0 0	Underground	—	—	—
	High-tension, alternating-current with transformers	2	1,500	per ann. 42 0 0	—			Underground	—	4½d. per unit	B
	Mordey-Victoria, alternate-current with transformers		—		—			—	—	—	C
	Alternating-current with transf'm'rs continuous-current low-pressure and storage batteries		—		—			—	—	7d. per unit	C
	Continuous-current, low-pressure 115 volts		—		—			Underground	—	6d. per unit	C
	—		—		—			—	—	—	C
	—		—		—			—	—	—	C
	Thomson-Houston, with Mordey alternators	—	1,000	per ann. £9 to 13	1/- pr. c.p. pr. ann.			—	—	—	D
	—		—		—			—	—	—	E
L.C.	High-tension parallel	1	300	1/- pr. c.p. pr. ann. —	730	17	—	Overhead	—	1/- per c.p. per annum.	C
	—		—		—			—	—	—	C
	—		—		—			—	—	—	C
	—		—		—			—	10 p.c. less than gas	—	C
y Co.	Low-tension, direct-current and secondary batteries		—		1000	12 & 16	0·4d. 0·4d.	Underground	—	7d. per unit	F
L. and td.	Low-tension, 120 volts		—		—			Overhead	—	Same as gas	F
Supply d.	Low-tension, direct-current		—								
	—		—								
	—										
ton Co.	—										
	—										

ne work, as the
ge batteries in readiness
ut is greatest. The batteries then
stored during the day, and so assist the
ngine power in keeping up the supply ; the batteries will also feed
he mains during the night after the heaviest part of the lighting
s shut off, in the case of all-night lighting.

by this system that the lighting of the greater number of towns is effected, and its advantages appear to be greater adaptability to the various requirements of the majority of towns, simplicity of machinery, and less cost of installation.

While admitting that in many towns, especially those containing dense areas, where the greater cost of installation is necessarily not the most important item, the low-pressure system is the most suitable, I am of opinion that the high-pressure alternating-current system is the one more likely to be found best for the

9. **An electric lamp for lighting and signalling at sea and land and for deep-sea fishing.** William Gordon Potter and Charles Midgeley, 8, Middle-pavement, Nottingham.

26. **An electric cable seating for laying in the cable for house-to-house supply for laying in the wires.** William Gordon Potter and Charles Midgeley, 8, Middle-pavement, Nottingham.

52. **Improvements in magnetic separators.** William Durant Hoffman, 6, Bream's-buildings, London.

65. **Improvements in and relating to conduits for electric conductors.** John Charles Love, 45, Southampton-buildings, London. (Complete specification.)

1891.

1069. **Gas, electric light, etc., lamps.** Brookes and Ward. 8d.
1905. **Distributing electric currents.** Atkinson. 8d.
12799. **Electric distribution.** Feilbogen. 6d.
13503. **Electric machines, etc.** Dobrowolsky and others. 11d.
14388. **Electric motors.** Dymond. (Gutman.) 8d.
14633. **Connecting electric wires.** Shiels. 8d.
14764. **Dynamo-electric generators, etc.** 8d. Thompson. (McLaughlin.)
16522. **Electrically soldering metal.** Thompson. (Coffin.) 6d.
16526. **Electric arc lamps.** Lake. (Tweedy.) 4d.

requirements of this town. I base my opinion of its suitability upon the success that has attended its use at the towns where I have seen the system in operation.

I have seen the various systems in operation at the following stations, of which a brief description may be of interest:

(1.) LOW-TENSION DIRECT-CURRENT SYSTEM.

St James and Pall Mall, London.—This is a typical station on this system and is eminently suitable for such a closely-confined area, the company having powers for supplying the parish of St. James, Westminster. The dynamos are supplied by Messrs. Latimer, Clark, Muirhead, and Co., and Messrs. Siemens Bros. and Co., and when complete there will be 12 sets of engines and dynamos. I ascertained that the cost of production per unit sold at 7d. was as follows: Coal, 1·01d.; superintendence, 0·26d.; wages, 1·42d.; sundries, 0·41d.—total, 3·1d.

(2.) HIGH-TENSION, DIRECT-CURRENT, WITH SECONDARY BATTERIES.

Chelsea, London.—This is a station worked on the principle of accumulators in sub stations at various convenient points in the district, which are charged at high pressure from the central generating station, the current being discharged from the accumulators at low pressure. The work of the accumulators is supplemented by continuous-current transformers, and feeding mains are run to various points on the discharging circuits. The mains are laid in a network and are all underground. The generating machinery was supplied by the Brush Electrical Engineering Company, the wiring by the Callender Bitumen Company, and the accumulators by the Electric Power Storage Company.

Kensington, London.—The system adopted here is very similar to the one previously described at Chelsea, but the accumulators are not subdivided at various points. I may say that I have never seen such brilliant and satisfactory illumination as at Kensington, the lighting there having an exceedingly beautiful effect.

(3.) HIGH-PRESSURE ALTERNATING CURRENT.

Sardinia-street, London.—A station of the Metropolitan Electric Supply Company. The whole of the plant has been laid down by the Westinghouse Electric Lighting Company. It is a very complete and typical station on the alternate-current transformer system. The dynamos are of the Westinghouse alternate-current type, and the wires are laid underground. The lighting is used for private purposes only.

West Brompton, London.—The Kensington station of the House-to-House Electric Light Company. This is a splendidly equipped station, the whole of the dynamos being uniform, of the Lowrie-Parker type, with Lowrie Hall converters. The wires are underground, and the lighting is at present confined to private purposes.

Weybridge, Surrey.—The streets of this town had never previously to being lighted by electric light, been lit at all; they are now lighted by 111 incandescent lamps of 32 c.p., each lamp burning from dusk to 1 a.m., and costing £2 per year, or £222 for the total. I think the lamps are too far apart to give the proper effect; such lighting would not be good enough for Tiverton. However, the fault is in the fewness of the lamps and not in the lighting station, which is admirably fitted with two dynamos of the Thomson-Houston type by Messrs. Laing, Wharton, and Down, the engines being duplicate vertical, compound, of 75 h.p., by Browett and Lindley. The wires are overhead, and the glow lamps fixed on brackets 13ft. from the ground.

Woking, Surrey.—At present only private lighting is carried out at this town; the streets are not lighted. The plant, capable of supplying 2,000 16-c.p. lamps, was manufactured and erected by Messrs. Woodhouse and Rawson. The dynamos are of the Kingdon type, which are claimed to be capable of working arc and incandescent lamps at the same time on different circuits, and so obviating the necessity of dynamos specially for arc lamps.

Fareham, Hampshire.—This town, which is about the same size as Tiverton, is very efficiently lighted entirely by electric light—arc lamps in main thoroughfares and glow lamps in side streets. The illumination in the main streets is all that can be desired, but [illegible] me. The glow lamps do not appear to have [illegible] not manifest to gas of the same candle-power, and judging from this example [illegible] am inclined to doubt the wisdom of replacing gas lamps by glow lamps, unless the candle-power is much increased or they are placed closed together, or for the same reason as at Fareham, so that all the lighting may be supplied from one source. The dynamos are supplied by Messrs. Laing, Wharton, and Down, and the wiring is overhead. The cost of lighting is almost the same as formerly by gas, but as regards the main streets is immensely superior to gas. The lighting is done by a local company paying a dividend of 5 per cent.

Bournemouth.—The lighting station is two miles out of the town, and is so placed for convenience of coal sidings, being adjacent to the railway. The engines and plant have been manufactured by the Brush Electrical Engineering Company, and the dynamos are of the Mordey-Victoria alternate-current type. The capacity of the station is equal to 4,000 to 5,000 10-c.p. lamps, and is worked by a local company. The lighting is used at present for private purposes only, but the station will be equal to the public lighting of the town when required; the wires are overhead with a few exceptions.

Taunton, Somerset.—The pioneer town of public electric lighting. This town was first lighted five years ago The first lighting station being too small for the requirements, a new station has been erected. The electrical plant has been laid down on the Thomson-Houston system, by Messrs. Laing, Wharton, and Down. A small Elwell-Parker plant charges accumulators in various parts of the town for motive power. A portion of the streets of the town are lighted by 31 arc lamps at about 100 yards apart; the [illegible] lighting is said to be about double that of the gas lamps, but this is more than compensated for by the extra [illegible] is a very good demand for private lighting, and consumers [illegible] themselves greatly in favour of the light. The local [illegible] a share capital of £20,000, and has paid 5 per cent. [illegible] and 6 per cent. the second year.

Bath, Somerset.—The principal streets are well lighted [illegible] lamps. The Thomson-Houston plant laid down by Messrs. [illegible] Wharton, and Down is used for the arc lighting, and the [illegible] for incandescent lamps are the Mordey-Victoria alternators [illegible] plied by the Brush Electrical Engineering Company [illegible] are underground, and the cost of the light is about [illegible] more than gas.

Exeter, Devon.—This station at present supplies [illegible] for private purposes only. Thirty arc and about 200 [illegible] cent lamps are in use; the Thomson-Houston dynamos [illegible] for arc lighting, and the Brush system for incandescent [illegible] The concern is worked by a local company, with [illegible] £25,000 in £10 shares, and the company do their own [illegible] and sell fittings. The station is fully equipped to [illegible] than double the present output, and all the machinery [illegible] cate. The electric lighting companies at Taunton, [illegible] Exeter owe their existence in each case to the enterprise [illegible] H. W. Massingham.

Lynmouth and Lynton, Devon.—This is a small [illegible] public and private lighting by incandescent lamps, [illegible] lamps being of 32 c.p. and 200 c.p. The plant was [illegible] Brush Electrical Engineering Company, and the dynamos [illegible] Mordey-Victoria alternators; power is obtained from [illegible] 14in. in diameter, developing 200 h.p., worked by water [illegible] River Lynn, having a fall in a 30in. pipe of 95ft. The [illegible] been carried out by Mr. Green, of Okehampton.

LAMPS.

The lamp generally used for street lighting purposes [illegible] lamp of 1,000 c.p. to 2 000 c.p., usually 1,200 c.p. [illegible] incandescent lamps, of from 8 c.p. to 50 c.p., being generally [illegible] for private lighting.

Incandescent lamps of 16 c.p. and 32 c.p. have been tried [illegible] lighting, but have not proved satisfactory. For the [illegible] streets the plan of using arc lamps in the main thoroughfares [illegible] incandescent lamps in side streets and at points where [illegible] is needed, answering well where proper attention is [illegible] situation of the lamps.

The charge made for an arc lamp of 1,200 c.p. varies [illegible] per lamp per hour at Galway to 3½d. at Eastbourne, or [illegible] to £35 per lamp per annum, and for incandescent lamps [illegible] per annum for 10 c.p. at Bath, to the more usual charge [illegible] candle-power per annum.

The price by meter, according to the Board of Trade [illegible] from 4½d. at Newcastle to 10d. at Eastbourne.

WIRES.

Most of the earlier installations were laid down with [illegible] wires, but the great danger and obstruction caused by [illegible] well as their unsightliness, has led to strong opposition [illegible] underground wires are now being laid down as a rule.

I may mention Bath as a very good instance [illegible] lighting of which is well laid out with the wires underground.

While I hope Tiverton will never be so disfigured as [illegible] have been, and that the Council will not allow overhead [illegible] in the town, there would not be the objection to overhead [illegible] between the lighting station and the town, in the event [illegible] station being situated at some distance from the town.

POWER.

Steam power for working the machinery is usually [illegible] and in all cases said to be perfectly satisfactory.

Water power is used with success at Okehampton, [illegible] Galway, and Greenock. I believe that water power [illegible] obtained from the River Exe sufficient for the purpose [illegible] this town, and if so, an immense saving in coal, boilers, [illegible] power [illegible] will be the result; the only period [illegible] dry summer, when [illegible] available, will be for about two [illegible] if this is found to be so, a [illegible] will be at its lowest [illegible] an auxiliary, which would be ver[illegible] steam plant could be laid [illegible] requiring to be done to the water machinery [illegible] in the event [illegible]

At any rate, the question is such an important one that I [illegible] the Council will act wisely in fully investigating the matter.

If water power be used, the lighting station must be [illegible] some miles up or down the river—this (independently of the [illegible] wiring the distance) will be no serious difficulty. At Bournemouth the lighting station is two miles from the town, and no [illegible] is felt.

I have enquired into the question of gas engines, but they [illegible] not made of sufficient capacity for town lighting, unless a [illegible] of engines are used, nor can they compete with steam [illegible] can be produced at from 1s. to 1s. 6d. per 1,000 feet. The [illegible] Economic Gas Company claim to be able to produce the [illegible] (made by passing superheated steam and air through red-hot [illegible] or coke) at an equivalent to this price, but in my opinion [illegible] small units of engine power rendering so much attention necessary is fatal to its use for central station work.

The power required for driving the dynamos for arc lighting [illegible] from ½ h.p. to ¾ h.p. per 1,000 c.p. of light produced, while [illegible] will drive about 10 16-c.p. incandescent lamps.

The horse-power required for such a plant as would serve the purpose of this town for some years, say, 30 arc lamps and [illegible]

Google

andescent lamps, would be from 75 h.p. in the summer, , in the winter.

COMPARISON OF COST WITH GAS.

arison of the cost with that of gas, although a question portance in considering the advisability of embarking on dertaking, is one of extreme difficulty and complexity, so nts having to be taken into account in making the com-

es amount paid for each illuminant, the amount of light each, and the relative adaptability or usefulness of the illuminating purposes, are all points that must be care- hed ; but, taking all things into consideration, it seems een estab'ished by the experience of most towns that the cost of public lighting by electricity exceeds that of hat the light given is much more intense and useful for mination. At the same time, I must instance one case— 'areham, a town of about the same size as Tiverton— e public lighting is carried out very efficiently, in my at about the same cost as the former charge for gas

PROVISIONAL ORDER.

ying out the terms of the provisional order, there are two es before the Council: (1) To carry out the lighting of themselves. (2) To transfer their powers under the other persons for a specified term, with the power of at the end of the term.

t my duty to strongly recommend the Council for the ot to adopt the first alternative ; everyday improvements nces and machinery are being made, and a public body is to so readily alter appliances and methods as is a manu- company, who are at all times in the market.

mend that the Council advertise for offers from persons nies to undertake the powers of the provisional order for d term, the undertakers to specify: 1. The system or hey propose to employ. 2. The charges they intend to . The date on which they will commence the lighting. rms on which the Corporation may, at the expiration of , purchase the plant belonging to the undertakers. Or, assistance of the Council, a local company might be n the town, to whom the powers of the order could be ed.

further details as to the lighting of other towns may be from the tabulated statement I have prepared (see pp. 525), and with a hope that the information laid before them useful to the Council in this most important matter.—I lemen, yours obediently,

J. SIDDALLS, Borough Surveyor.

PROVISIONAL PATENTS, 1891.

NOVEMBER 16.

lectric spiral lamp for general lighting purposes for ailway carriages, tramcars, and cabs. William Gordon otter and Charles Midgeley, 8, Middle-pavement, ottingham.

nprovements in gravity control, as applied to electric easuring instruments. William Alfred Crook and enry John Payne, 1, Riverview, The Terrace, Barnes, urrey.

nprovements in dynamo brushes. James Dickson and obert George Shapcott, 4, South-street, Finsbury, ondon.

NOVEMBER 17.

nprovements in incandescent electrical lamps. James tkinson, 3, Nassington-road, Hampstead, London.

nprovements in telephone closets, and other structures here it is desirable that they should be practically ound-proof. Thomas Weighill, 6, Lord-street, Liverpool.

nprovements in or relating to welding or working etals electrically. William Phillips Thompson, 6, Lord- reet, Liverpool. (Charles L. Coffin, United States.) omplete specification.)

nprovements in or relating to welding or working etals electrically. William Phillips Thompson, 6, Lord- reet, Liverpool. (Charles L. Coffin, United States.)

nprovements in telephonic transmitters. Alexander arr, 70, Market-street, Manchester.

nprovements in or connected with electric arc lamps. ohn Brunswick Barton, 34, Southampton-buildings, ondon. (William Jandus, United States.)

n electric lamp for lighting and signalling at sea nd land and for deep-sea fishing. William Gordon otter and Charles Midgeley, 8, Middle-pavement, ottingham.

n electric cable seating for laying in the cable for ouse-to-house supply for laying in the wires. illiam Gordon Potter and Charles Midgeley, 8, Middle- avement, Nottingham.

nprovements in magnetic separators. William Durant offman, 6, Bream's-buildings, London.

nprovements in and relating to conduits for electric onductors. John Charles Love, 45, Southampton- uildings, London. (Complete specification.)

19968. **Improvements in electric motors and dynamos.** Martin Charles Burt, 115, Cannon-street, London. (Complete specification.)

19971. **Improvements in or connected with electrical measuring and indicating apparatus.** Erhard Ludwig Mayer, Norfolk House, Norfolk-street, London.

19972. **A new or improved device for varying the resistance in telephone circuits.** Erhard Ludwig Mayer, Norfolk House, Norfolk-street, London.

19975. **Improvements in and relating to electric arc lamps or lighting apparatus.** Frederic Victor Maquaire, 3, Avenue du Maine, Paris, France.

NOVEMBER 18.

19996. **Improvements in electric alarum clocks.** James Nicholls, Lowtown, Pudsey, near Leeds.

20026. **Improvements in multiple switchboards for telephone exchanges.** Guillaume Arnaud Nussbaum, 29, Ludgate-hill, London. (Louis Mandroux, France.)

20033. **Improvements in dynamo-electric machines.** Samuel Dickinson Williams, Moorlinch House, Clytha Park, Newport, Monmouth.

20059. **An electric gondola.** Jessie Hutchinson, 11, Furnival-street, London.

20063. **Improvements in the use of transformers.** John Ambrose Fleming and Reginald Thomas Dudley Brougham, 28, Southampton-buildings, London.

NOVEMBER 19.

20078. **An improved automatic and electric check-till.** Robert Gay and William Henry Jackson, 5, Clover Hill-terrace, Halifax.

20109. **Improvements in electric switches.** Wilson Henry Sturge, 12, Cherry-street, Birmingham.

20111. **Improvements in methods of electrical distribution.** John Hall Rider, The Northern Telegraph Works, Halifax, Yorkshire.

20139. **Improvements in electric signals or indicators.** John Thomas Gent, Alwyn Walter Staveley, and Isaac Hardy Parsons, 4, South-street, Finsbury, London.

20144. **A new or improved system of communicating visible signals and establishing electrical and telephonic connection between central town and district stations, and mechanism and appliances connected therewith** Charles Eggar, 96, Buchanan-street, Glasgow.

NOVEMBER 20.

20215. **Improvements relating to electrical machines and to reversing and interrupting apparatus for use in connection therewith.** Cornelius Bennett Harness, 11, Southampton-buildings, London. (Complete specification.)

20217. **Improvements in dynamo machines.** Joseph Sinclair Fairfax, 433, Strand, London.

NOVEMBER 21.

20226. **Improvements in arc electric lamps.** Thomas Barnet Grant, 15, George-street, Mansion House, London.

20230. **Improvements in electric arc lamps.** John Hall Rider, Northern Telegraph Works, Halifax.

20234. **A method of and apparatus for telephonic transmission.** Erhard Ludwig Mayer, Norfolk House, Norfolk-street, London.

20247. **Improvements in solenoids, particularly applicable to automatic sound signalling apparatus, but which may also be used for other electrical purposes.** John Stirling Yule and Charles Kerr Marr, 62, St. Vincent-street, Glasgow.

20257. **An improved electric arc lamp.** William Phillips Thompson, 6, Lord-street, Liverpool. (La Compagnie de l'Industrie Electrique, successor and representative of La Société d'Appareillage Electrique, Switzerland. (Complete specification.)

20279. **Improvements in electric cables.** George Gatton Melhuish Hardingham, 191 Fleet-street, London. (The firm of Felten and Guilleaume, Germany.)

SPECIFICATIONS PUBLISHED.

1890.

19034. **Electrical testing apparatus.** Jones and others. 6d.

20898. **Dynamo-electric machines.** Leigh. (Desroziers.) 8d.

21116. **Electric arc lamps.** Gay and Hammond. 8d.

21224. **Telephonic circuits.** Abel. (Société Générale des Telephones and another.) 8d.

1891.

1069. **Gas, electric light, etc., lamps.** Brookes and Ward. 8d.

1905. **Distributing electric currents.** Atkinson. 8d.

12799. **Electric distribution.** Feilbogen. 6d.

13503. **Electric machines, etc.** Dobrowolsky and others. 11d.

14388. **Electric motors.** Dymond. (Gutman.) 8d.

14633. **Connecting electric wires.** Shiels. 8d.

14764. **Dynamo-electric generators, etc.** 8d. Thompson. (McLaughlin.)

16522. **Electrically soldering metal.** Thompson. (Coffin.) 6d.

16526. **Electric arc lamps.** Lake. (Tweedy.) 4d.

ELECTRIC COMPANIES.

The specimen table given below shows certain information we desire to make complete, and we shall be glad i readers will assist us by sending such information as they may be able to give.

Name.	Address.	Managing Director or General Manager.	Manager or Secretary.	Electrical Engineer.
Acme Electric	Ferdinand-street, N.W.		Francis Teague	—
Acton Hill Works	Acton, W.	Ronald Scott	C. N. Russell	—
Bessbrook and Newry Tramway	Bessbrook, co. Armagh		H. Harrison	Dr. Hopkinson.
Birmingham Electrical Supply	Dale End, Birmingham	J. C. Vaudrey	W. Christian	—
Birmingham House-to-House	39, Bennett's-hill, B'ham		A. H. Gibson	—
Blackpool Tramway	Blackpool	B. Broadbent	R. Handley	M. Holroyd Smith.
British Insulated Wire	Prescot, Lancs.	J. B. Atherton		—
British Propulsion	Victor-road, Holloway, N.	S. Lambert		W. D. Sandwell.
Brush Electrical Engineering	49, Queen Victoria-st., E.C.	E. Garcke	B. Broadhurst	J. S. Raworth, R. P. Sellon
Callender's Bitumen Cable	101, Leadenhall-street, E.C.	T. Callender	S. Lambert	—
Camberwell and Islington	5, Victoria-street, S.W.	V. D. Cooper	R. McInglis	—
Devonshire Electric Light	5, Victoria-street, S.W.	V. D. Cooper	R. McInglis	—
Chagford and Devon	Chagford, Devon		G. H. Reid	W. J. McSweeney.
Chelsea Supply	Draycott-place, Sloane-square	Major-General Webber.	S. J. Cluer	W. H. Tasker, H. Talbot.
City of London Brush Station	Bankside			B. Deakin.
City of London Electric Lighting	1, Great Winchester-street		J. C. Bull	—
City and South London Railway	46, King William-street, E.C.	T. C. Jenkins	H. H. Smith	B. Mott, J. H. Greathead.
Crompton and Co.	Mansion House-buildings, E.C.	J. F. Albright, R. E. Crompton	F. R. Reeves	—
Devon and Cornwall	2, Courtenay-st., Plymouth		G. Murray	—
Eastbourne Electric Light	Eastbourne	H. W. Wilkinson	H. Towner	H. W. Wilkinson.
East Coast Electric Light	5, Victoria-street, S.W.	V. D. Cooper	R. McInglis	—
Edison-Swan	100, Victoria-street, S.W.	S. Flood Page	S. Flood Page	—
Electric Construction	Worcester House, Walbrook	J. Ebb-Smith, T. Parker	F. Walton	T. Parker.
Electric Installation	4, Great Winchester-st., E.C.	G. Offor	E. Stables	—
Exeter Electric Light	Exeter	H. J. Massingham	H. W. Michelmore	T. P. Wilmshurst.
Fareham Electric Light	Fareham	Capt. J. Ramsay	A. Blake	—
Foreign and Colonial E.P.S.	4, Great Winchester-st., E.C.		E. Stables	H. Musgrave.
Fowler-Waring Cables	32, Victoria-street, S.W.	A. E. Mavor	D. Stephens	—
General Electric	71, Queen Victoria-st., E.C.	G. Binswanger		—
General Electric Power & Traction	35, New Broad-street, E.C.	R. Macpherson	W. G. Mackenzie	Albion T. Snell.
Gordon and Co.	11, Pall-mall, S.W.	W. J. Rivington	H. Sinclair	T. Tomlinson.
Hastings, etc., Electric Light	Earl-street, Hastings	H. M. Baker	F. E. Burton	E. T. Mercer.
Henley's, W. T.	27, Martin's-lane, E.C.		G. Sutton	—
House-to-House Electric Light	Richmond-road, S.W.	R. Hammond	H. Winkworth	—
India Rubber and Gutta Percha	106, Cannon-street, E.C.	M. Gray	W. J. Tyler	R. K. Gray.
International Okonite	99, Queen Victoria-st., E.C.	A. V. Stephens	P. J. Bordessa	—
Keys' Electric	122, Charing Cross-rd., S.W.		G. Wandrus	A. Reckenzaun.
Laing, Wharton, and Down	82A, New Bond-street, W.	C. J. Wharton		—
Laurence, Scott, and Co.	Gothic Works, Norwich	— Scott	A. F. Armstrong	W. B. Sisling.
Liverpool Electric	15, Highfield-st., Liverpool	A. B. Holmes	B. H. Collins	—
London Electric	3, Adelphi-terrace, W.C.		Major C. B. Waller	—
Manchester Edison-Swan	14, St. Ann's-sq., Manchester	W. P. J. Fawcus	J. E. Sharples	—
Metropolitan Electric	4, Waterloo-place, S.W.	E. S. Claremont	E. C. Owen	F. Bailey.
Newcastle and District Electric Light	38, Grainger-street West, Newcastle-on-Tyne	Hon. C. A. Parsons	J. Patterson	W. O. Hunter.
Newcastle-on-Tyne Supply	Pandon Dene, Newcastle-on-Tyne	R. C. Jackson	J. Hesketh	—
Norwich Electric	Norwich		G. B. Kennett	—
Notting Hill Electric Light	9, Austin Friars, E.C.		W. H. Fox	—
Phosphor Bronze	87, Sumner-street, S.E.		R. Lagerwell	—
St. James's and Pall Mall Electric Light	Masons'-yard, Duke-st., S.W.	J. Strick		S. Dobson.
Siemens Bros. and Co.	12, Queen Anne's-gate, S.W.	L. Loeffler	E. Kaiser, A. Sabine	—
Southampton Electric Light	Southampton		J. T. Hamilton	G. W. Aldridge.
Taunton Electric Light	Taunton	H. J. Massingham	F. C. Bostock	H. E. Hunt.
Westminster Supply	32, Victoria-street, S.W.	Capt. Bax	F. Iago	Prof. Kennedy.

NEW COMPANIES REGISTERED.

Railway Electrical Fog Signal Syndicate, Limited.—Registered by S. G. Warner, 6, Quality-court, W.C., with a capital of £25,000 in £1 shares. Object: to carry into effect an agreement, made October 27, between W. Andrews of the one part and J. Prus, jun., on behalf of this Company, of the other part, and generally to carry on business as electrical engineers, engineers, boilermakers, etc. The first subscribers are:

	Shares.
A. Moore, Victoria-road, Netherfield, Notts	1
J. Lewin, Victoria-road, Netherfield, Notts	1
W. Langsdale, 152, Radford Boulevard, Notts	1
S. P. Derbyshire, Wheeler-gate, Nottingham	1
M. Gregory, 10, Colwich-road, West Bridgford, Nottingham	1
G. Tutin, Station-road, Breston, Notts	1
F. H. Bedells, 2, Burns-street, Nottingham	1

There shall not be less than three nor more than nine Directors; the first to be appointed by the signatories to the memorandum of association. Qualification, 250 shares.

CITY NOTES.

Venezuela Telephone Company.—At the first ordinary general meeting of this Company, held on Friday last, a dividend at the rate of 4 per cent. per annum was declared for the half-year ended June 30, 1891.

City and South London Railway.—The receipts for the week ending November 22 were £793, as against £819 for the week ending November 15.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Brush Co.	—	3⅝
— Pref.	—	2¾
India Rubber, Gutta Percha & Telegraph Co.	10	19⅛
House-to-House	5	5
Metropolitan Electric Supply	—	10⅜
London Electric Supply	5	1⅝
Swan United	3½	4½
St. James'	—	9⅛
National Telephone	5	4⅜
Electric Construction	10	7⅛
Westminster Electric	—	6⅝
Liverpool Electric Supply	5 3	5⅛ 2⅛

NOTES.

Macclesfield.—The Lighting Committee of Macclesfield are proposing to extend their street lighting.

"Decorative Electricity."—A second edition of Mrs. Gordon's book with the above title will appear in a few days.

Electric Pleasure Boats.—A successful trip has just been made of a pleasure boat driven by electric motor and batteries on the Seine at Paris.

Melbourne.—Temporary installations are coming into use in Melbourne for building operations. There should be plenty of opening for this kind of plant in Australia.

Paris.—The Continental Edison Company will shortly install a large battery of accumulators at the Rue Drouot central station, the demand at which already exceeds the supply.

Kensington Mains.—The Kensington and Knightsbridge Company have received sanction from the London County Council to lay mains in Kensington-square and King-street.

City Lighting.—The request of the City of London Electric Light Company for an extension of time was discussed at the meeting of the Commissioners of Sewers on Tuesday and refused.

Tramways for Warrington.—The Parliamentary Sub-Committee of the Warrington Town Council has been instructed to report upon the best means of providing tramways within the borough.

Warrington.—The Gas Committee have decided that the subject of supplying the borough with electric light be referred to the Works Sub-Committee, with instructions to report thereon to the committee.

Chicago World's Fair.—Mr. James Dredge will read a paper on "The World's Columbian Exposition at Chicago" before the Society of Arts on Wednesday next, Dec. 9. The Attorney-General will preside.

Personal.—Lord Suffield, one of the Prince of Wales's household, and chairman of the Westminster Electric Supply Corporation, is lying ill at Manchester-square, having undergone an operation in the throat.

Police Signalling.—An exhibition has been given at Glasgow of a police-signalling apparatus designed by Captain Paterson, of the Glasgow Fire Brigade, which has been approved by the Watch Committee.

Electric Tramways in Italy.—An electric tramway is shortly to be installed in Naples. We learn also that a tramway is in process of construction at La Spezia, and electric traction will probably be employed.

Dynamo for the London County Council.—The London County Council have authorised their committee to purchase for £450 an alternate-current dynamo, switchboard, and fittings for testing electric meters.

Middlesbrough.—We understand that the Middlesbrough Electric Lighting Company propose to lay mains in a number of streets of Middlesbrough for the purpose of supplying consumers with the electric light.

Rotherham.—The Gas Works Committee of the Rotherham recommend that a sub-committee be appointed to confer with Mr. Newbegging with reference to the extension of the gas works and adoption of the electric light.

Tasmania.—A syndicate has been formed to utilise water power on a very extensive scale for the purpose of transmitting motive power by means of electricity to the numerous mines on the Mount Leehan and Dundas, in Tasmania.

Blackpool Tramway.—It was mentioned at the annual meeting of the Blackpool Electric Tramway that the Corporation had intimated they wished to take over the enterprise. Mr. Hoyle advised the directors to oppose them strongly.

President-Elect.—We understand that Prof. Ayrton is to be the President of the Institution of Electrical Engineers for next year. Prof. Ayrton has worked hard for the advancement of electrical science, and well deserves to fill the honourable post to which he is destined.

Lenses.—The paper read at the meeting of the Society of Arts on November 25th was on "The Measurement of Lenses," by Prof. Silvanus Thompson, a subject which he has made specially his own after that of dynamos. The paper is fully given in the society's *Journal* for last week.

Lisbon.—The two gas companies in Lisbon have at last amalgamated. The municipal authorities have authorised the fusion, and the shareholders of both concerns have expressed their approval of the statutes of the new company, which will be styled Companhias Reunidas de Gas e Electricidade.

Mr. Cyrus Field, according to a Reuter's telegram from New York, lies in a prostrate condition, and it is feared that the probability of his recovery is but slight. His daughter, Mrs. Lindley, is also so seriously ill that her life is almost despaired of. The blow is due to the failure of his son's firm.

Christiania.—The municipal authorities of Christiania have concluded a contract with Messrs. Schuckert, of Nuremberg, for the supply of the necessary plant, accumulators, and mains for lighting that city by electricity. The cost of the establishment of the station and distribution will amount to £37,500.

Glasgow.—The Electric Lighting Committee of the Glasgow Town Council have made arrangements for the purchase of a site for the erection of buildings in which to place the electric plant for lighting the central area of Glasgow. The ground is situated in Bishop-street, Anderston, and the price to be paid is £8,000.

St. Helens.—A sub-committee has been appointed by the St. Helens Gas and Highway Committee to consider the question of the supply of electricity within the borough, with a view to its being provided at an early date, and also to consider the various methods of enriching the illuminating power of gas without increasing the cost.

The Crystal Palace Installation is making very rapid progress, the walls being up and the roof on. Both engines and dynamos will be completed within the next few days. There is every indication that the station will be ready to supply current as stated by the contractors, Messrs. J. E. H. Gordon and Co., at the opening of the exhibition.

Dusseldorf.—The Municipality of Dusseldorf opened its central electric station on the 24th of last month. The system comprises three sub-stations of accumulators, the dynamos of the central station giving current for 10,000 lamps of 16 c.p. The mains have a capacity for 25,000 lamps. The orders in hand amount to 16,000 lamps, and 12,000 are already supplied.

Sheffield.—As the Corporation and the Sheffield Telephone Exchange and Electric Light Company, Limited, have now come to an agreement with regard to the provisional order which the latter are promoting, the Corporation are not proceeding with the application of which they gave notice, and the meeting of the Council summoned for December 16 next to adopt a memorial to the Board of Trade will not be held.

Canterbury.—At the fortnightly meeting of the Canterbury General Purposes Committee the Mayor made a very definite statement as to the effect of the Corporations Act, 1882, preventing any member interested in gas companies voting on the electric light. The proposed draft agreement between the Corporation and the Brush Company was discussed in private.

Royal Society.—The annual meeting of the Royal Society was held on Monday, the anniversary address being given by the president, Sir William Thomson. The Copley medal was awarded to Prof. Stanislao Cannizaro for his contribution to chemical science, and a Royal medal to Prof. Rücker for his researches on liquid films and contributions to the knowledge of terrestrial magnetism. Sir William Thomson was again elected president.

Manchester.—The scheme for providing electric light for the central station of Manchester is not progressing so fast as proposing consumers desire. It was understood that the whole scheme was ready to be carried out, but little progress seems yet to have been made. The delay is attributed to some difficulty which has arisen as to the selection of a site for the generating station, but this is now overcome, and the work will be proceeded with at once.

Nottingham.—It is suggested by a correspondent in the *Nottingham Guardian* that it would be possible to use the power now running to waste down the River Trent and the River Lien to light up the town and drive the tramcars. If power could not be utilised at the Trent Bridge and on the River Lien at Lenton, it is thought that sufficient head of water could be obtained at Colwick or Beeston Weir to drive a number of turbines. Another correspondent suggests artesian wells.

Crompton Alternator.—"Is Saul also among the prophets?" we shall hear asked on reading the above heading. Mr. Crompton bringing out an alternator! However, we believe the news to be quite sound, and that a new design of alternating dynamo is being built by Messrs. Crompton, with revolving field magnets and fixed armature coils with iron cores. The Crompton alternator will not be unlike the Mordey at first sight, though it differs considerably in construction and design.

Telegraphic Typesetter.—A description is given in the *Times* of Wednesday of an ingenious invention by Major Law, commercial attaché to the British Embassy at St. Petersburg, of a typewriter which is to be employed to work an electric typesetter over a single wire at a distance. It is suggested that a London paper might set up its type at various provincial centres. As, however, we have yet to obtain a thoroughly successful ordinary typesetter, this idea seems sanguine, if not chimerical.

Bangalore.—Messrs. Binny and Co. have recently introduced the electric light into their oil mill in the Pettah. The cost of the whole of the machinery amounted to a little over 2,000 reals, and Messrs. Binny and Co. hope, says the *Indian Engineer*, to make a saving by the introduction of the light before long, as the same engine that is used on the works will also work the dynamo. The cost of candles and oil amounted to about 3,000 reals a year, and the whole system of lighting was unsatisfactory.

Dangers of Gas.—An occasional accident may sometimes occur in connection with the electric light, but we can never have such a terrible explosion by electric means alone as that which occurred this week in a gas explosion at Blackburn. There, by a meter going wrong, a whole hotel was lifted bodily by the force of the explosion and dropped in a confused heap of wreckage with fatal results. The total effect is described as if one of the largest modern bombs had been suddenly dropped and exploded in the middle of the town.

Application of Electricity to Mining.—On Saturday the first of a series of seven lectures on this subject was delivered in the Guildhall, Derby, under the auspices of the Midland Counties Branch of the National Association of Colliery Managers and the Derbyshire County Council. There was a large attendance under the presidency of Mr. J. P. Jackson, J.P., chairman of the Technical Institution of the County Council. The lecturer was Mr. George Fletcher, headmaster of the science department of the Derby Technical College.

Old Students' Association.—The recent report of this association shows a membership of 201, and a satisfactory financial balance. The medal of the association has been awarded to Mr. Ernest B. Vignoles, for his paper, entitled "Some Researches in Electromagnetic Induction." The next meeting will be held at Finsbury College on Wednesday, Dec. 16, at 8 p.m., when a paper will be read by Mr. Rollo Appleyard, entitled "The Measurement of the Resistance of Conductors containing Disturbing Electromotive Forces, with Special Reference to Earth Plates."

Telephone Wires.—The National Telephone Company have prepared a Bill of very wide scope. It will give them power, if it be passed, to carry their wires anywhere, both overhead and below ground, and to attach them to any building, whether the owner consent or not. The only protection afforded to the property owner is an appeal to the Board of Trade, "or other public body or local authority," who may impose terms, conditions, and restrictions. The Bill would enable the company to invade a man's property, not only once, but as often as the necessities of testing and repair required them to do so.

Dundee.—A meeting of the Works Committee of the Dundee Gas Commission was held on Monday, when the question of electric lighting was again considered. Six sites in various parts of the city were spoken of as suitable for an electrical station. The committee resolved to purchase ground in Seagate to the extent of 34 poles. The proposed site is in the compulsory area, near a railway siding at the harbour, owned by the Commissioners of the North, and is large enough for an extensive installation. Bailie Perrie moved that the ground be sold to the Gas Commissioners at £4. 10s. per pole, without the usual restrictions, and this was carried.

Cardiff.—Mr. Sidney F. Walker has written to the *South Wales Daily News* maintaining that large incandescent lamps are preferable to arc lamps for the street lighting of Cardiff. He is backed up in this view by Mr. Lance Davies, of the United Electrical Company, Cardiff, but another correspondent asks Mr. Walker (1) whether he has seen the lighting of the Continental cities; (2) whether he holds an agency for the "Sunbeam" lamp. Even if he does, there is no reason why Mr. Walker should not ventilate his views on the subject, but we doubt whether a town such as Cardiff would be wise to adopt high-power incandescent lamps rather than arcs for its public streets.

Provisional Orders.—The following is the list of electric lighting provisional orders to be proceeded with in the forthcoming session of Parliament: Ashton-under-Lyne, Aberyswith, Brighton, County of London (South), County of London (North), Dublin, Govan, Hackney, Hampstead, Harwich Corporation, Halifax Corporation, Kilkenny, Limerick, Middlesbrough, Maidstone, Newbury, St. Mary, Islington (Electric Supply), Sheffield (application for provisional order by the Sheffield Telephone Exchange and Electric Light Company, Limited), Shoreditch, Sutton (Surrey), Woking Electric Supply Company, Limited, Waterford, Whitechapel, West Ham Corporation, Waterford, Walton-on-Thames.

St. Pancras Lighting.—Electric lighting is fast becoming a subject of general popular interest, and as such deserving of considerable place in daily journalism. In pursuance of such feeling we are pleased to see the *Daily Graphic* for Thursday give an interesting interview with Mr. Eccleston Gibb, the vestry clerk of St. Pancras. Already they are supplying 3,000 lights. "It will pay us well," Mr. Gibb is reported as saying, "when we are running full load." We hope and trust so, but it is too early yet to make definite statements. The whole current will shortly be all used, it is stated, and the Vestry are even now looking out for fresh stations.

Bahamas Cable.—Arrangements have been made for connecting the Bahama Islands in the West Indies with the general telegraphic system of the world and the mother country. The project consists in laying a submarine cable of about 200 miles in length from a point about five miles from Nassau, New Providence, to a point about the same number of miles from Jupiter Inlet, on the south-east coast of Florida. The cable, which has been designed for the Government of the colony by Mr. W. H. Preece, F.R.S., the electrician to the Post Office, will be insulated with guttapercha, and is being manufactured by Messrs. W. T. Henley and Co. It will be laid in January or February next by the steamer "Westmeath," belonging to that firm.

Quick Telephony between Towns.—A public call-room has recently been opened in Tewkesbury by the Western Counties and South Wales Telephone Company. The *Tewkesbury Record* representative was, at the occasion of the opening, put into communication with Cheltenham, and a report which we have before us was transmitted for press. It was spoken from Tewkesbury to Cheltenham in the limit of time allowed to users of the telephone for communication between towns, and is, we think, one of the smartest pieces of telephone work which has ever taken place. There are 700 words in the report, and to communicate that number of words in three minutes indicates a great deal of smartness on the part of the sender and receiver.

Henley's Cables.—We have received the catalogue and price list of the Henley's Telegraph Work Company's cables. This firm, it may be remembered, were awarded the only gold medal at the Inventions Exhibition for excellence of cables. The present catalogue deals specially with electric light cables and wires, with full details of tests, sizes, weights, and prices. From the instructions for jointing we might quote the following four important and sensible rules printed therein: "Avoid acid in soldering—use resin where necessary; do not use too much solution; lap the rubber as lightly as possible; cleanliness is of the utmost importance—where possible the work should be divided, see that one man does the cutting, another the soldering, a third the lapping, and so forth: it is certain a man with hands smeared with solution cannot make a clean joint." The catalogue also deals with flexibles and jointing material, and should be in the hands of everyone who needs to purchase or use electric light wire.

House-to-House Mains.—The Highways Committee of the London County Council have considered three notices, with a plan attached to each, from the House-to-House Electric Light Supply Company of intention to lay electric supply cables (*a*) in a part of Earl's Court-square, (*b*) in Fopstone-road, and (*c*) on the south side of Old Brompton-road between Thistle Grove-lane and Drayton-gardens. The proposed works are of the kind approved by the Council on previous notices of this company; and they recommend that the sanction of the Council be given to the works referred to, upon condition that no pipes of a larger diameter than 6in. shall be used; that the street boxes shall be of the pattern approved by the Council, and that, as an additional precaution against accident through defective insulation of the mains, each of the street boxes shall be provided with an inner as well as an outer cover, the two insulated from each other as far as practicable, and that the outer cover shall be efficiently connected with earth.

Annual Dinner.—The employés of Messrs. S. Z. de Ferranti, Limited, held their annual dinner at the Wool Exchange Restaurant, Coleman-street, on Saturday evening last, when an excellent repast was provided, and an exceptionally pleasant evening was spent by the men and their guests. Mr. Kilgour, the foreman, was in the chair, and was ably supported by Mr. Pascoe in the vice-chair. After the usual loyal toasts, the chairman proposed the health of the firm, and Mr. Ferranti, in replying, referred to the position which the electrical industry has now attained, and the fact of their having been so actively engaged at the inception of it should give them something to look back upon in years to come with considerable pleasure. The electric light particularly had passed through serious difficulties, both legislative as well as financial, but now that it had got free of these he predicted an extension upon which it is hardly possible to speculate at present. Mr. Sparks, in also replying, said that the chairman of the company (Mr. Ince) had hoped to have been present, but he was unable to be so owing to ill-health.

Electric Tramcars at Croydon.—On Monday afternoon, Major-General Hutchinson and Captain Cardew visited Croydon for the purpose of inspecting, on behalf of the Board of Trade, the working of a new electric tramcar, several similar to which are about to be adopted by the Croydon Tramways Company. The Government inspectors were met at the company's depôt by the Mayor of Croydon (Mr. Councillor F. T. Edridge), the town clerk (Mr. C. M. Elborough), the chairman of the Roads Committee (Mr. Councillor Foss), several members of the Corporation, and the borough road surveyor (Mr. Archer), a director of the Electric Tramcar Syndicate, and Mr. H. A. Durke, manager of the Croydon Tramways Company. The tramcar, which is on the Jarman system with accumulators, weighing in all 5½ tons without passengers, is driven by two motors of 14 h.p. nominal, and can attain a maximum speed of 16 miles an hour. A trial trip was first of all made to Thornton Heath, after which the whole of the circuit to North-end, Croydon, was completed without a hitch, and the inspectors expressed themselves as being thoroughly satisfied with the experiment.

Institution.—The annual meeting of the Institution of Electrical Engineers will be held on Thursday, December 10, for the reception of the annual report, and for the election of Council and officers. A paper "On the Specification of Insulated Conductors for Electric Lighting and other Purposes" will be read by Mr. W. H. Preece, F.R.S. The list of proposed Council and officers are as follows: President, Prof. W. E. Ayrton, F.R.S.; vice-presidents, Alexander Siemens, R. E. Crompton, M.I.C.E., Sir David Salomons, M.A., Sir Henry Mance, M.I.C.E.; Council, Major G. W. Addison, R.E., Sir Albert J. L. Cappel, K.C.I.E., Sir James Douglass, F.R.S., Prof. J. A. Fleming, M.A., D.Sc., Prof. George Forbes, F.R.SS. (L. and E.), Colonel R. Raynsford Jackson, W. M. Mordey, Prof. Silvanus P. Thompson, B.A., S.Sc., F.R.A.S., Edward Hopkinson, M.A., D.Sc., M.I.C.E., Prof. A. B. W. Kennedy, F.R.S., M.I.C.E., Prof. John Perry, D.Sc., F.R.S., Jas. Swinburne; associate members of Council, Captain L. A. Beaumont, R.N., M. Cooper, Captain W. C. Hussey, C.E.; hon. treasurer, Edward Graves (past president); hon. auditors, Frederick C.

Danvers, Augustus Stroh; hon. solicitors, Messrs. Wilson, Bristow, and Carpmael.

Utilisation of Water Power in France.—A large scheme is announced for tender for the utilisation of the power of the River Dranse, tributary of the Rhone, near Martigny, Valais. The fall is 200 metres, volume of water 5,000 litres per second, and the total force therefore about 10,000 h.p., allowing 25 per cent. loss. The estimated cost is about 1,400,000f. (£56,000) for works, races, and reservoirs. The company only desire to utilise 6,000 h.p. at first, and opens to competition projects for its utilisation in establishment of works for electric manufacture of aluminium, chlorate of potash, and electro-metallurgy, great latitude being allowed as to propositions. A description of proposed works and processes, a general plan, an estimate of first cost, and a description of the carrying on of proposed works are desired. For this premiums will be given, but only a restricted number of competitors will be received; several persons or firms may join. The projects must be sent by the end of February, 1892, for the Société des Eaux de la Dranse, to MM. Cuenod-Churchill et Fils, banquiers, Vevey (Vaud) France under motto, sealed. A premium of 4,000 francs will be awarded to the author of the best project, and a second premium of 2,000 francs to the next best; a third premium of 1,000 francs will be given or not as found desirable. The projects will remain the property of the company.

Secondary Batteries.—The electrical public are particularly favoured lately with text-books on special subjects, but hitherto there has been a decided lack of aggregated information upon the subject of the different kinds of storage batteries or accumulators and their principle and manufacture. We gave a few months ago a very interesting series of articles by Mr. J. T. Niblett, now the general manager of the Mining and Electric Lamp Company, on "Secondary Batteries," the embodiment of a paper read before the Glasgow Physical Society. These articles reprinted were very soon exhausted, and we are now able to announce that these articles, thoroughly revised and with much additional matter, fully illustrated, will be published shortly from the office of this journal in book form, price 2s. 6d. It will include a description of all the recent developments of practical storage cells, together with numerous curves, tables, and data, in four parts and an appendix. Part I. will deal with lead plates of the Planté type, Part II. with lead peroxide cells of the pasted or Faure type; Part III., lead-zinc, copper zinc, alkaline, and other forms; Part IV., solid storage cells; and also the electrolyte and methods for measuring its density. The appendix will deal with electrical measurements as applied to storage cells; materials used in construction, with other practical information and figures.

Electric Light Lectures.—We give in another column a portion of a lecture by Mr. Guss Metzger, which was delivered at Hendon on Monday last, together with the discussion which followed. The lecture contains nothing that is new, but the discussion shows very plainly how little a knowledge of even the elementary facts connected with the distribution and utilisation of electrical energy are known or appreciated by the general public—that is to say, by the very people to whom electrical engineers are looking for the adoption of electric lighting. What Mr. Preece said the other day at the Mansion House meeting was quite true. The application of the productions of the electrical engineer are only limited by the ignorance of the public. Well! why not educate the public, and as the public won't be educated of its own accord and initiative, we must perforce gather them together in small units and lecture at them. Such lectures as that of Mr. Metzger, though very elementary, want to be given in every hole and corner of the United Kingdom, and the more the audience can be stirred up to ask questions the better. In fact, a confederate on these occasions to set the ball rolling by putting a poser to the lecturer is not only permissible, but necessary. Once start the queries and they will only be limited by the number of tongues present. An interest in the matter will have been aroused which will probably lead to certain of the energetic spirits finding out more for themselves from papers and books. We want more of these elementary lectures, even though they be in the nature of advertisements of one particular system. If the ignorance of the public stands in their way, electrical engineers should see that it is removed.

Nottingham.—At the next meeting of the Nottingham Town Council, on December 7, the Electric Lighting Committee will report that, in pursuance of the resolution of the Council passed in May last, they have obtained the services of two experts to report on the action which should be taken by the Town Council under the provisional order of the year 1890. These experts are Dr. J. Hopkinson, F.R.S., and Mr. W. H. Preece, F.R.S. Both concur in the opinion that the Town Council should undertake the electric lighting of the borough under the powers of the provisional order, and by no means to allow such powers to fall into the hands of private companies. They also are of opinion that any capital invested in electric lighting by the Corporation will not only return a fair percentage upon the outlay, but ultimately be a source of profit. The committee unanimously concur in the recommendation of the experts with respect to the propriety of the Town Council undertaking the electric lighting of the borough under the provisional order, thereby preventing a monopoly of the electric lighting falling into private hands. The committee add that they cannot fully concur in the expectation of the experts that for some time to come the supply of electricity to the borough could be made a source of profit. They are of opinion that this is an over-sanguine view of the question. They are, however, unanimously agreed that the time has arrived when the town should have the benefit of electric lighting, and that the responsibility should be undertaken at once. Whatever may be the pecuniary result for the first few years, it will be of more advantage to the town than allowing a monopoly to be created in the hands of private persons, which might have to be repurchased on extravagant terms. The committee recommend that the electric lighting should be undertaken at first in a tentative way, and that the compulsory area only should be at first provided for. They recommend that they should be authorised to prepare a specification of the works required, and to engage such professional assistance as they may require.

Edison's New System.—The public interest which was recently aroused by the announcement of a new electric railway system by Edison has hardly yet subsided, and while the public no doubt believe a wonderful discovery has been made, and then probably forget all about it, yet electrical engineers are wondering what foundation there is in all the varied and brilliant reports. Our esteemed contemporary and namesake of New York has sent up a special representative to interview Edison, and find out what really is being done, or rather proposed. It seems that Mr. Villard, as long ago as 1880, applied to Mr. Edison to devise a system of electric railway which should be cheap of operation, and act as branch feeders to the main lines. More recently Mr. Villard, having become president of the Edison Company, requested Mr. Edison to devise a street railway system without trolleys, and of simple

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construction, and not costing more than a cable road to instal. The scheme Edison adopted, reverting to his idea of ten years ago, was the transformation of high-tension direct currents at 1,000 volts, by motor generators under the streets, to 20 volts between rail and rail. This scheme has, of course, no striking novelty, but the details were difficult to satisfactorily work out. It was necessary to have a contact which would pick up 1,000 amperes at 20 volts through some inches of mud if necessary. Then it was necessary to have a joint between contiguous rails to allow the passage of several thousand amperes without undue resistance. An experimental track on these lines has been working for some time past near Edison's laboratory to his complete satisfaction. Experiments on short-circuiting by iron wheels and bars were carried out. The loss with a wet and salted track was 5 h.p. per mile, and in the worse conditions found in practice only 2½ h.p. per mile. No shock can, of course, be felt with 20 volts. The cost is estimated at from £6,000 to £20,000 per mile, while cable roads are twice this, while the efficiency of cable is 18 per cent. against a probable 50 per cent. of the electric system. We give this information in abstract as given in a prominent position in our contemporary, who adds that estimates are being prepared for the conversion of one of the largest of the New York street railways on this system.

Bristol.—Mr. W. H. Preece has recently issued an important report to the Bristol Electrical Committee. He recommends the adoption of the locomotive type of boiler. Objections were taken by a member of the committee to certain points in the specification, and the latter had been revised, but Mr. Preece replies that it has been impossible to meet the views of the member referred to in every respect, because that would mean the use of the Lancashire type of boiler, which would restrict the capacity of the central station, so that eventually they would have to provide a second station on another site; whereas with the locomotive boiler the capacity of the station would be adequate for the wants of the present generation. If the use of local coal was imperative, the Lancashire boiler would have to be adopted; but understanding that good Welsh coal is equally applicable, he would prefer using that. The capacity of the proposed plant is 10,000 lamps of 16 c.p., and 96 arc lamps for street lighting. There would be two arc dynamos, each capable of lighting the 96 lamps. These would be of 96 i.h.p., giving 80 amperes at 650 volts. There would be six steam alternators, four of them to be 330 h.p., each capable of lighting 3,000 16-c.p. glow lamps, delivering 100 amperes at 2,000 volts, and two to be 120 h.p., each to light 1,000 16-c.p glow lamps, delivering 37 amperes at 2,000 volts. Sufficient power is therefore provided to allow one steam alternator of 330 h.p. and one of 120 h.p. to be used as spare plant. There would be three separate switchboards—one for arcs, and one for glow lamp substation circuits, and one for distributing the exciting currents. The arc lamp board would have the two machines connected, and from thence the eight circuits would be distributed. The glow lamp board would be so arranged that half could be altered or repaired without disturbing the running. The arc lamps had been arranged in eight circuits of 12 lamps each, but as far as possible successive lamps would belong to independent circuits, obviating entire breakdown, and allowing half the lamps to be extinguished. The arc light mains would be laid in cast-iron pipes under the pavement on both sides of the street, and each circuit being distinct. The lampposts are to be of handsome design. With regard to the glow lamps, it was proposed to place sub-stations at or near the Victoria Rooms, College-green, Baldwin-street, Council House, and Old Market-street. The glow lamps would be fed from low-pressure mains on the three-wire system, at 200 volts, forming local networks around each sub-station. Mr. Preece believes the cost of production will be below that given in the original estimate.

Hull Engineer's Report.—A meeting of the Hull Corporation Electric Light Committee was held last week to consider the proposed central station. The minutes of the sub-committee, which were confirmed, contained a report by Mr. Harman Lewis, the electrical engineer, in which he laid before the committee the general arrangement of plant which he recommended. The plant represented 560 i.h.p., and when working to full load, without any spare plant, was capable of supplying 4,250 16-c.p. lamps. He had designed it so that it could be increased to 960 i.h.p. to supply 7,400 16-c.p. lamps, by the addition of two boilers, two steam dynamos, a condenser, and the necessary connecting piping. The boilers were of the return-tube kind, known as the Economic, and each capable of evaporting 4,200lb. of water per hour at 150lb. pressure. The two large engines were each of 200 i.h.p., and run at a speed of 350 revolutions per minute, and the two smaller 80 i.h.p., each running at 460. The dynamos were those of Messrs. Siemens, and were simple shunt-wound, the two larger being constructed to give 1,000 amperes at 115 volts, whilst the two smaller ones were each wound for 300 amperes at 150 volts, so that if necessary they could be employed for charging batteries. A surface condenser would be used of a type in which the air and circulating pumps were combined together with it so as to be as compact as possible. Mr. Lewis said he would recommend the erection of a feed-tank and small water-softening apparatus to supply the extra water required. After referring to the feed-pumps and injectors, the traveller, the chimney, the coal bunker, the report went on to say that the total length of the mains would be about 4,600 yards. Although the strained bare copper strip in a cement culvert was insulating, and straining-up boxes was probably the cheapest kind of main consistent with efficiency, he did not recommend the adoption of the Crompton system in its entirety, which he considered had an inherent defect in the straining-up method. He estimated the cost of the plant as:

Three Economic boilers, including setting, at £560	£1,680	0	0
Pumps, injectors, and necessary pipes	200	0	0
Four dynamos, with two spare armatures, including lifting sling	2,430	10	0
Two 80-i.h.p. compound engines at £400—£800			
Two 200-i.h.p. compound engines at £796—£1,592	2,392	0	0
Steam, exhaust, and condenser pipes, with necessary valves and erecting	1,000	0	0
Condensing plant	800	0	0
Switchboard and instruments	500	0	0
Building alterations	2,000	0	0
Overhead traveller, with erecting	150	0	0
Water-softening apparatus and feed-tank, with erecting	225	0	0
Cost of station	11,377	10	0
4,600 yards of main, at 33s. 2¾d. per yard	7,642	14	2
	19,020	4	2
100 meters, at £7 each	700	0	0
	£19,720	4	2

Some discussion arose on the advisability of providing accumulators, and ultimately it was referred to the electrical engineer for a full report.

SOLAR STRESS CONSIDERED AS THE CAUSE OF TROPICAL HEAT.

BY DR. SHETTLE.

In the *Electrical Engineer* of November 13th, I endeavoured to define the manner in which solar and lunar stress are productive of terrestrial magnetism. In the following remarks I wish to show the mode in which it would appear that *solar stress is productive of heat.*

Before attempting to establish my points it will be well to call attention to certain well-known facts which are very pertinent to the enquiry. These are:

1. That whilst it is well known that all bodies expand during the process of being heated, the cause of the expansion is not known.
2. That as the earth retains its shape and motions, we have proof that whilst the centripetal must be in excess of the centrifugal force, yet the one is so adjusted to the other that the normal conditions are maintained.
3. That constant and regular changes are occurring in atmospheric pressure, which coincide with the relative positions of the sun and the earth.
4. That whilst Joule's law shows that a definite quantity of heat is capable of being transformed into a definite quantity of mechanical work, "combustion is a complete illustration of the potential, latent, intrinsic energy becoming active or kinetic, and taking the form of heat."

Taking the above as the fundamental principles upon which the theory is based, I will deal with them in what appears to be the order of importance; and, as it would seem that all matter would be resolved into a thin ethereal vapour were it not affected by gravity, gravity must be considered first.

In gravity we have a force by which "every portion of matter attracts every other portion of matter, and the stress between them is proportional to the product of their masses, divided by the square of the distance."

Consequently we find that whilst every atom of matter in the earth, or in the sun, is being drawn to the centre of each body by terrestrial or by solar gravity, as the case may be, there is a secondary manifestation of stress between the two bodies as masses, which stress, in proportion to its intensity, counteracts the central tendencies of the atoms. Thus as the earth performs its axial and orbital motions, and retains its shape under the influence of terrestrial gravity, we recognise that the centripetal must exceed the centrifugal manifestation of force. But as a certain amount of bulging exists in the equatorial regions, it is evident that the centripetal has not absolutely controlled the centrifugal manifestation.

This bulging of the earth's surface is unquestionably due to solar and lunar stress, but it also signifies that terrestrial gravitation is proportionately less in the equatorial regions. It is produced by atomic leverage, as I described in my paper on magnetism. The tides give ocular proof of the mechanical effect of the stress on the liquid part of the earth's surface, where friction is reduced to a minimum.

But when we consider the effects of solar stress in the production of heat we recognise:

1. That the intensity of that stress on the surface of the earth must vary with the relation which any part holds to the line which passes through the centre of the two bodies.
2. That in proportion to the intensity of the stress mutually exerted by the two bodies, the pressure consequent upon the central (terrestrial and solar) manifestation of gravitation must be reduced.
3. That in proportion to reduction of central pressure the elastic energy of the atoms (*i.e.*, the tendency of the atoms to resume the ethereal state) must be increased.
4. That in proportion to the expansion of the atoms their inherent potential energy is productive of friction and heat, as in ordinary combustion.

With regard to the polarising influence of stress, and the consequent motion of the atoms under change in the direction of that stress, there can be no question, because every form of matter has a specific description of resistance to the transference of energy, or motion; and this resistance determines the polarity of its atoms, or the line which they assume under stress. This must be the case, because the same law holds good with the atoms as with the mass: the greater contains the less.

We further perceive that if the surface heat of the earth is caused by the elastic energy of the atoms, when relieved from gravitational or centripetal attraction by solar stress, it follows that the heat of the sun and of any similar body can be kept up on the same principle without any diminution of energy; and thus the theory of the conservation of energy is supported, even in its application to the maintenance of solar heat.

THE DISTRIBUTION OF ELECTRICAL ENERGY.*

BY W. C. RECHNIEWSKI.

(Continued from page 371.)

Utilisation of Water Power.—The most favourable case for the utilisation of water power, though, unfortunately, one not very often met with, is that where the fall of water is situated in the centre of the district to be lighted.

The construction of the works required may be more or less difficult, and, consequently, costly. Taking 40,000f. (£1,600) for this work, including the erection of turbines, we shall be considering a favourable case. Under these conditions, the cost of establishment of a 200-h.p. station may be calculated as follows:

	f.	£
Water works and buildings	40,000	(1,600)
Three 100-h.p. turbines (one spare) with accessories and gearing for dynamos	20,000	(800)
Three 100-h.p. dynamos	30,000	(1,200)
Switchboard and instruments, etc.	10,000	(400)
Total first cost	100,000f.	(£4,000)

This is 45,000f. (£1,800) less than the first cost of a steam-driven central station. This price, however, depends essentially upon difficulties of dealing with the water supply, and may become very much higher.

The cost of maintenance may be calculated as follows:

	f.	£
One electrical engineer	3,600	
Two mechanical engineers	5,200	
10 per cent. depreciation and repairs on 60,000f. (machines)	6,000	
5 per cent. on 40,000f. (buildings)	2,000	
5 per cent. interest on 100,000f.	5,000	
Total	21,800f.	(£872)

It is seen, then, that if it were desired to double the power of the station, either 100,000f. worth of accumulators could be added, or the mechanical power of the station could be doubled; the annual expenses, as well as the first cost, would be practically the same in the two cases, taking, of course, a mean duration of two hours per lamp per day.

In practice it would be preferable, if there were sufficient hydraulic power at disposal, to double the mechanical installation because of the simpler working of turbines and dynamos, and more particularly because of the possibility of employing this motive power to run electric motors in the daytime. The use of accumulators would be left to those cases where the hydraulic power is insufficient; this arrangement then enables the output of the station to be doubled without very great expense. This solution is that of the future, when it will be necessary to utilise to the utmost all natural forces; indeed, places where there is more power than required are sufficiently rare already, and will become more and more so as the use of water power increases.

Alternate Currents.—The use of alternate currents is no advantage except where power is required to be transmitted to a considerable distance. As, however, the alternate-current system is used in some cases, even for small and thickly-populated districts, we shall consider these cases, taking, in the first place, the cost of lighting by alternate currents of a district of 500 metres radius with 3,500 lamps of 10 c.p.

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* Translated from *L'Electricien.*

1. CENTRAL STATION.—ALTERNATE-CURRENT SYSTEM.

		f.	£
Buildings and offices		33,000	(1,320)
Three sets of machines of 100 h.p., with boiler, piping, engine, each	24,000		
Dynamo, 100 h.p.	19,000		
Three sets at	43,000	129,000	(5,160)
Switchboard, instruments, etc.		10,000	(400)
Total for the central station		172,000f.	(£6,880)

The high-tension current will be transformed into low-tension currents of 100 or 50 volts, and distributed to the houses. We may suppose that each transformer distributes for a radius of 100 metres around it. There are, therefore, 25 transformers required for the whole circuit, of a capacity of 6,000 watts each.

With the continuous current we have allowed 0·4 ampere per square millimetre; with the alternate current we can go much higher. It is not, in this case, the variation of voltage, but the heating of the wire and its mechanical resistance which comes into play.

I do not think that for this reason we should allow a greater current density of more than 1·2 to 1·6 ampere per square millimetre. Taking this latter figure, we shall have 4,820 kg. (10,600lb.) of copper on the high-tension mains, and about the same weight in the low-tension mains, a total of 9,640 kg. We will admit, as for the continuous-current system, that the cost of running cost only 20,000f. (£800), which presupposes overhead wires. We shall obtain under these conditions, for the cost of mains, etc.:

2. MAINS.

	f.	£
25 transformers of 6,000 watts at 600f.	24,000	(960)
9,640 kg. at 2f. 50c.	24,100	(964)
Erection	20,000	(800)
Total for mains	68,000f.	(£2,724)

We arrive, therefore, for the alternate-current mains, at the same price as with the continuous-current.

It is, however, necessary to consider that the laying will cost more for the alternate current for several reasons. In the first place, there are two sets of mains, the high-tension mains and the low-tension mains; secondly, the greatest precautions are necessary for the insulation of the high-pressure mains. We have not taken these differences into account, but in practice they would certainly make themselves felt. Lastly, the impossibility of employing accumulators, or, up to the present at least, of driving small motors, are both against the use of alternate currents—the more so that this system costs more in the case we have been considering.

When employing underground conductors the weight of the copper does not give any idea, even approximate, of the price of laying mans. The details themselves of the distribution must be gone into and studied for each particular case.

Dealing with totals, the first cost of mains amounts for our district of 500 metres and 3,500 lamps with overhead wires to $\frac{213,200}{3,500} = 61$f. for continuous current in simple parallel at 110 volts, and $\frac{230,100}{3,500} = 66$f. for the alternate current; as we have said above, would probably be much greater because of the greater precautions to be taken for the insulation of the high-tension wires for the alternate current.

We must still further remark that the efficiency of the installation with alternate currents is less than that with the continuous currents; this results, in the first place, from the fact that the efficiency of continuous-current dynamos is higher, at any rate up to the present, than that of the alternate-current dynamos, and, further, from the loss in the transformers, which, though relatively small at full load, is relatively high at small loads.

The efficiency of the ordinary transformers of commerce exceeds 90 per cent. at full charge, but, nevertheless, cannot even come up to 50 per cent. for a 24 hours' run, of which three or four are at full load, and the remainder empty or at light load.

We may admit that the first cost of establishment is the same when the weight of copper per lamp, with continuous current, reaches 10 kg. (22lb.). Under these conditions we can easily see that the continuous current with conductors in parallel at 110 volts will be preferable, whenever the radius of the district to be lighted does not exceed 671 metres.

With feeders the radius can be increased to 1,000 to 1,100 metres.
With the three-wire system, to 1,074 metres.
With the three-wire system and feeders, to 1,650 to 1,850 metres.
With the five-wire system, to 2,000 to 2,200 metres.
With the five-wire system and feeders, to 3,000 to 3,600 metres.

For distances greater than this, the alternate-current system would be cheaper. An advantage will be found in employing it even for less distances when the total number of lamps is not very large and where no motors are required, a case often presented by large villages and small towns. The working of a small central station with alternate currents is rather simpler than that of a small station on the five-wire system, for instance.

Continuous Currents with Sub-Stations.—When the distance to be supplied extends for more than 300 metres from the central station, the continuous-current distribution with sub-stations can be employed in the following way:

At the central station a current of 2,000 volts, for instance, is produced and transformed in the sub-stations by means of "dyna-motors" or continuous-current transformers into currents at 120 volts, or at 240 volts for the three-wire system, etc.

The most economical and rational method in this case will be as follows:

Each sub-station is fitted with accumulators, which are charged during the daytime. For lighting, the battery and the dynamos work in parallel. This system is employed at London by several companies. To obtain an idea of the price of this distribution we will take the case of lighting 3,500 lamps in a perimeter of 500 metres radius placed 10 kilometres (say six miles) from the generating station. We may choose under these conditions two dynamos of 1,500 volts in series at the station, so as to obtain a difference of potential of 3,000 volts. Two continuous-current transformers with their primary circuits in series will absorb this voltage, and furnish current at 120 volts from their secondary armature circuits, which can be connected in parallel.

The cost of such an installation will be:

(1) GENERATING STATION.

	f.	£
Two generators, 1,500 volts and 30 amperes	18,000	(720)
One continuous-current transformer	9,000	(360)
Instruments	10,000	(400)
Buildings, etc. (same in both cases)	,,	,,
	37,000f.	(£1,480)

(2) LINE.

30 mm.^{2} section, length 2 × 10 = 20 kilometres.

	f.	£
About 6,000 kg. of copper at 2f. 50c.	15,000	(600)
200 poles with insulators at 25f.	5,000	(200)
Erection	,,	,,
	20,000f.	(£800)

(3) SUB-STATION.

	f.	£
Buildings, offices, etc.	20,000	(800)
Three continuous-current transformers (one spare)	39,000	(1,560)
Battery of accumulators, 600 amperes, 120 volts, for three hours	43,000	(1,720)
Switchboard, etc.	10,000	(400)
	112,000f.	(£4,480)

In all 169,000f. (£6,760), without reckoning steam engines or turbines, and distributing mains going from the sub-station to the lamps.

If it were desired to run this station with the alternate current, the cost would be about the same, consequent upon the fact that accumulators not being employed, the dynamos would require to be of much greater power; so also with the conductors.

(1) GENERATING STATION.

	f.	£
Three alternate-current dynamos of 120 h.p. (one being spare)	60,000	(2,400)
Instruments, etc.	10,000	(400)
	70,000f.	(£2,800)

(2) Line.	f.	£.
70 mm.^{2} section, length 20 km., about 1,400 kg. of copper at 2f. 50c.	35,000	(1,400)
200 poles and insulators	5,000	(200)
	40,000f.	(£1,600)

(3) Transformers.	f.	£
Total capacity of 300 h.p. (of these we are obliged to provide more than is actually necessary, because the maximum capacity must be considerably over the mean output)	20,000	(800)
Building and fixing	20,000	(800)
Various	10,000	(400)
	50,000f.	(£2,000)

In all 160,000f. (£6,400).

The cost of the two systems is practically the same, and it can only be special conditions which should exert an influence in favour of one or the other. The continuous-current system has thus an incontestable advantage when the power of either steam engines or turbines is limited at the generating station. Indeed, the use of accumulators enables 3,500 lamps to be run with a total motive power of 120 h.p. only, working, it is true, eight to ten hours a day, while with the alternate current 220 h.p. to 240 h.p. would be required, which would only be working during the actual hours of lighting—that is, from three to four hours only a day. On the other hand, the labour and superintendence of an alternate-current station is rather simpler and requires a smaller staff of men.

(*To be continued.*)

SECONDARY BATTERIES.*

BY G. H. ROBERTSON, F.C.S., ASSOC.INST.E.ENG.

Introduction.

The secondary—or, as it should rather be called, the reversible—battery dates practically from the discovery that electric currents could be produced by the agency of chemical actions, and its development progressed with the increase of our knowledge of the laws which govern electrolysis.

In the year 1800, Volta discovered that a current could be obtained through chemical agency; and in the following year Gautherot observed that when electrodes of silver or platinum wire were used for the electrolysis of acidulated water, they gave a current in the reverse direction to that in which the battery current had been passing, if they were connected through a galvanometer directly the battery was removed.

These inverse, or polarisation currents as they were called, were a source of great perplexity, and although much work was done on the subject, and many theories were started to account for their origin by Volta, Ritter, Marianini, Becquerel, Grotthus, and others, no satisfactory explanation was forthcoming until Faraday set the whole theory of electrolysis on a firm basis in his papers communicated to the Royal Society between June, 1833, and March, 1834.

Although many apparent contradictions have been found to Faraday's well-known simple laws, and the precise mode in which a current is conveyed through an electrolyte is still under discussion, yet his work showed that chemical and electrical energy were mutually convertible, and that the so-called polarisation currents were due to the reversible nature of the chemical changes caused by the passage of the primary current.

The way was thus cleared for improvements in batteries in general, and very many have been brought out; but it was not till much later, when Faraday's other great discovery of the laws relating to the conversion of mechanical into electrical energy bore fruit, and provided a cheap source of electricity, that much attention was paid to reversible batteries.

In the course of his experiments on electrolysis he nearly anticipated Planté's discovery of the peroxide of lead-lead couple, for in the case of the electrolysis of a solution of acetate of lead he noticed that on the passage of the current peroxide of lead was formed on the one plate and lead on the other.

In 1843, Grove invented his gas battery, and in 1852 Dr. C. W. Siemens constructed a reversible battery, using carbon plates as his electrodes, and a strong solution of acetate of lead as his electrolyte.

In 1859, Planté made a number of experiments with copper, silver, tin, lead, aluminium, iron, zinc, gold, and platinum voltameters, to determine which was the best couple to use for a reversible battery, and decided on the use of lead plates in dilute sulphuric acid, because in discharge both plates were active—that is, not only did the peroxide of lead plate combine with hydrogen, but the reduced metallic lead combined with oxygen; thus the E.M.F. of the cell was due to chemical actions occurring on both plates. In those days the action of the cell was ascribed solely to the decomposition of water, and the effect of the sulphuric acid was left out of account.

In 1872, Planté improved the "formation" of his cell by bringing out the process for alternate reversals of the current, and in the decade which followed, with the improvement of the dynamo, and the consequent growth of electrical engineering, the need for some means of storing electrical energy arose, and the reversible battery passed from the laboratory into commercial use.

Reversible Batteries.

In 1880, M. Camille Faure invented his cell, in which the electrodes consisted of lead plates, smeared with pastes of red lead and litharge respectively, and covered with a protecting layer of felt. On charging, the red lead was oxidised to peroxide of lead, and the litharge was reduced to metallic lead, thus quickly forming a Planté couple of considerable storage capacity.

The same impetus in electrical work which gave rise to the Faure battery, led also to the introduction of several other types of reversible batteries, and as I have been able to obtain very little information about them, I will deal with them and their developments now, before proceeding with the numerous improvements in the two lead types.

Profs. Thomson and Houston have tried electrodes of copper in sulphate of zinc solution; the plates were laid horizontally, so that the relative weights of the sulphate of zinc and sulphate of copper formed in the working might prevent their mixing too readily. The E.M.F. was the same as that of the Daniell.

M. d'Arsonval modified this battery by making one electrode of lead and the other of zinc, the solution being sulphate of zinc as before. The lead plate forms the positive, and becomes coated with peroxide during charge. According to Miesler, the E.M.F. of this arrangement is 2·13 volts.

Sutton tried copper and lead plates in copper sulphate, the E.M.F. being 1·22 volts.

In 1886, M. Dezmazures brought out a modification of the Lalande and Chaperon cell, the solid copper plate being replaced by a porous one, made by first reducing copper oxide electrically, and then compressing the fine metallic dust so obtained into plates.* The other electrode was made of tinned iron gauze, and the solution was potassium zincate. The E.M.F. is only about one volt, but the cells are light, and a battery of this description gave satisfaction as a source of motive power, at the trials on the French torpedo-boat "La Gymnote," at Toulon. Recently this battery has been tried for traction work in Philadelphia, under the name of the Waddell-Entz accumulator.† In the American form of the battery the copper plates are made of a sort of wire rope, formed of a stout wire core, braided over in opposite directions with two layers of wire of different thicknesses, the finest outside. This is again braided with asbestos, or some similar material, which retains and protects the copper oxide formed by electrolysis. The weight of the battery is given as from 55lb. to 60lb. per horse-power stored.

Lead Reversible Batteries.

On the introduction of the Faure cell into England, in 1881, great hopes were entertained of it, and the modification in the manufacture of the plates seems almost to have been regarded as constituting a fresh type of cell, whereas, since the couple was identical, the chemical reactions were the same as in the Planté cell, and any defect due to these would be common to both. As lead reversible batteries cannot be said to have completely realised the hopes then entertained, it is important to discover whether the non-fulfilment is due to causes which can be remedied by improved processes of manufacture, or whether they arise from the chemical reactions occurring in the working of the cell, and are to be met rather by improved treatment after than during construction. I have thought, therefore, that a paper containing a summary of some of the principal improvements which have been introduced in the construction of the cells, and an account of some experiments dealing with the chemistry of the subject, might lead to some useful discussion.

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* Paper read before the Society of Arts.

* The *Electrician*, vol. xxii., p. 302.

† The *Electrical Engineer*, No. 23, vol. vii., p. 556.

From a comparison of the two cells, made by M. Achard, it appears that on its introduction the internal resistance of the Faure was much higher than that of the former, while the Planté cell took longer to form, and was heavier than the Faure.

The time required for formation, and the weight of the cell, were the chief drawbacks to the Planté process of manufacture; the Faure method had the disadvantage that the applied paste was liable to separate from its support. The remedying of these defects, then, has been the principal aim of the improvements which have been brought out in the two types of the lead reversible battery.[*] To give a complete list of these would be quite beyond the scope of this paper, but they may be summarised as follows:

I. IMPROVEMENTS IN THE PLANTE TYPE,

i.e., that in which the peroxide of lead and spongy lead are formed direct from metallic lead by electrolysis.

In this type, since both the weight of the plate and the time required for "formation" can be shortened by making the plate porous, and thus exposing more surface to the action of the acid and charging current, obtaining porosity has been the chief aim of inventors. The methods which have been suggested from time to time may be classified under three headings: *a. Chemical.*—The plates are subjected to some "pickling" process, or some special "forming" bath is used. *b. Mechanical.*—The plates are made of granulated lead, wire, or some form of finely-divided lead. *c. Electrolytic.*—(1) The finely-divided lead is obtained by the electrolysis of some salt of lead; (2) Some salt of lead is formed into a plate by pressure or otherwise, and then reduced to metallic lead.

Chemical Processes.—Planté found that plates of lead which had been steeped for a long time in dilute sulphuric acid, before being submitted to the action of the charging current, "formed" more rapidly than those which had not been so treated, and he also found that "formation" was hastened by heating the cell during the process; this, however, was difficult in practice.

In 1882, in order to roughen the surface, he pickled the plates, for from 24 to 28 hours, in a bath composed of nitric acid diluted with from once to twice its volume of water. The plates were then thoroughly washed, and the formation completed in a bath of dilute sulphuric acid one to 10. By this improvement he stated that a capacity which under the old process it took several months to obtain, could be acquired in eight days.

Almost simultaneously, Messrs. Elwell and Parker suggested the use of a mixture of nitric and sulphuric acids as a pickling bath. Since then different baths, containing nitric acid in varying proportions, have been brought out, and from the earliest times the addition of some salt of the alkalies, such as ammonium, sodium, potassium, or magnesium, sulphate to the electrolyte during formation, has been suggested as an improvement.

In 1884, Mr. FitzGerald proposed the use of phosphoric acid; and in the same year Mr. Tribe experimented with plates partially or wholly converted into sulphide, phosphide, or arsenide, prior to "forming" then by electrolysis.

Coming to recent processes, in 1890 Mr. Epstein suggested first boiling the electrodes in a bath containing

1 per cent. nitric acid;
1 ,, ,, potassium permanganate;

or else, in lieu of the permanganate, 2 per cent. carbonate or sulphate of sodium, or 1 per cent. sulphate of manganese. The plates are dried in air, and then "formed" by the action of the current in an electrolyte containing acetic, phosphoric, or tartaric acid, in the proportion of ½ to 2 per cent.

A few months later, Dr. Paul Schoop brought out his process for first subjecting the plates to the action of a current of about one-sixth of an ampere per 100 square centimetres, at 50deg. F., in a bath composed either of:

100 parts by weight ammonium sulphate;
140 ,, ,, ,, sulphuric acid (50deg.);
⅔rds 1 pt. ,, ,, potassium chlorate:

or else—

100 parts by weight water;
5 ,, ,, ,, sodium bisulphate;
⅔rds 1 pt. ,, ,, potassium chlorate.

The treatment is continued for from 36 to 100 hours, according to the depth of the active material required. The formation is completed in ordinary dilute sulphuric acid.

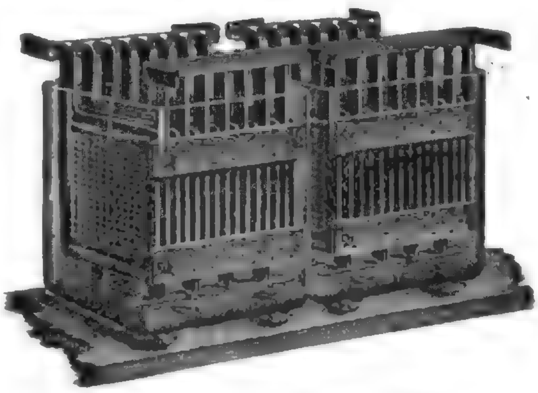

FIG. 1.—Drake and Gorham's Cell.

Mechanical Processes.—Messrs. Crompton and Howell's well-known plates, formed by the compression of a specially porous granulated lead, are an instance of this type, and from their great porosity they are capable of a very high rate of discharge.

In Messrs. Drake and Gorham's cell, Fig. 1, while the positives are of the Faure type, the negatives, or lead plates, are formed of roughened strips of lead, laid horizontally one over the other, and connected by their ends to upright rods. From its construction this plate is free to expand and contract without injury to itself.

In Mr. Niblett's so-called "solid cell,"[*] the electrodes are separated by porous partitions, and the space between the electrodes and the partitions is filled up with granulated lead. In this cell there is practically no free electrolyte to wash about and spill; it is all absorbed either in the mass of spongy material forming the electrodes, or in the porous partitions.

Plates have also been made of compressed lead dust, of wire loosely woven and compressed, as in Reynier's cell; or in the form of a rope, as in the Legay cell.

M. Bandsept's plates would appear to be of this type, as they are made of extremely finely pulverised material, which is then compressed into briquettes, and subjected to a forming process. The cell is now in use commercially in Brussels, but very little information can be obtained about it.

ELECTROLYTIC PROCESSES.

1. *The Electrolysis of Some Lead Salt Solution.*—The acetate of lead has been frequently employed for this purpose since Siemens used it; and another salt that has been the

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[*] For an account of the lead batteries on their first introduction into commercial work, and of the early suggestions to replace them, see a paper by Prof. W. Grylls Adams, F.R.S., read before the Science Society of King's College, October 25, 1881, and published in the *Chemical News*, vol. xlv., p. 1. In Mr. Niblett's paper on "Some Recent Improvements in Lead Secondary Batteries," read before the Physical Society of Glasgow University last January, and published in the *Electrical Engineer*, vol. vii., Nos. 13 to 17, will be found an account of the principal structural improvements which have since been effected.

[*] The *Electrical Engineer*, vol. viii., No. 4, p. 80.

subject of many patents is the chloride of lead. In America last year it was proposed by an Englishman, named Currie, to form the electrodes of rods or bars of lead coated with woven asbestos. These electrodes are then placed as anodes in a bath of zinc chloride, and lead chloride to the required depth is formed on them, while zinc is deposited on the cathodes. On reversing the current, spongy metallic lead is produced on what are now the cathodes, and the zinc goes into solution, being thus used over and over again.

2. *The Reduction of a Plate Formed of Some Salt of Lead.* Perhaps more patents have been taken out under this heading than any other. Plates have been formed of the fused chloride; cerussite, or the native carbonate, has been compressed into plates, and, in fact, any salt of lead, even lead sulphate, which can be got to reduce to metallic lead by the action of the current, has been employed.

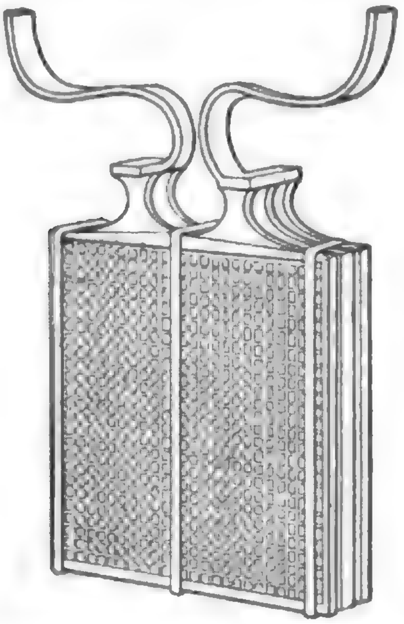

FIG. 2.—Element Consolidated Electric Storage Company.

In the Laurent-Cèly cell the plates are composed of pastilles of specially-prepared lead chloride, round which frames of an alloy of lead and antimony are cast. By the action of zinc in very dilute hydrochloric acid, the plates are converted into cellular lead. The plates are then washed in cold water, dried, and the positives converted into litharge by the action of a current of hot air. The formation is then completed by electrolysis in the usual way.

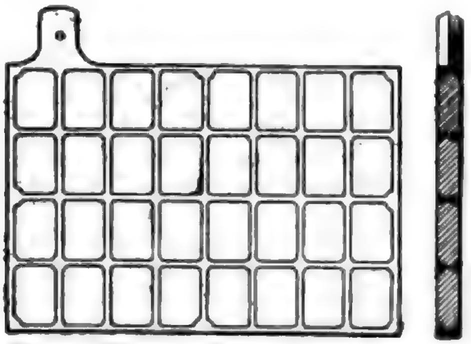

FIG. 3.—Plan and Section Gadot Plate.

For this cell it is claimed that the density of the positives is 4·3 to 5, while that of the negatives is only 3 to 3·5. Great storage capacity for weight is also claimed.

II. IMPROVEMENTS IN THE FAURE TYPE,

i.e., that in which the peroxide of lead and spongy lead are formed by electrolysis from some oxide applied to the plates.

As in this class of cell the active material is applied to the electrodes, and not formed from them as in the original Planté cell, it is obviously desirable that the supporting part of the electrode should be light, and not weakened by taking part in the chemical reactions. These requirements have been met in many instances by replacing the solid lead plate by a grid, usually made of an alloy of lead and antimony, since such an alloy is less acted on by the acid, and is much stronger than pure lead. In the E.P.S. cell, the use of an alloy of lead and antimony was abandoned, because, if sufficient antimony to obtain a good casting was added, the grid was so hard that it did not yield to the expansion of the paste, which consequently forced itself out of the plate. Lead grids were then employed, but now they have been abandoned for rapid discharge work, and a solid plate has been reverted to.

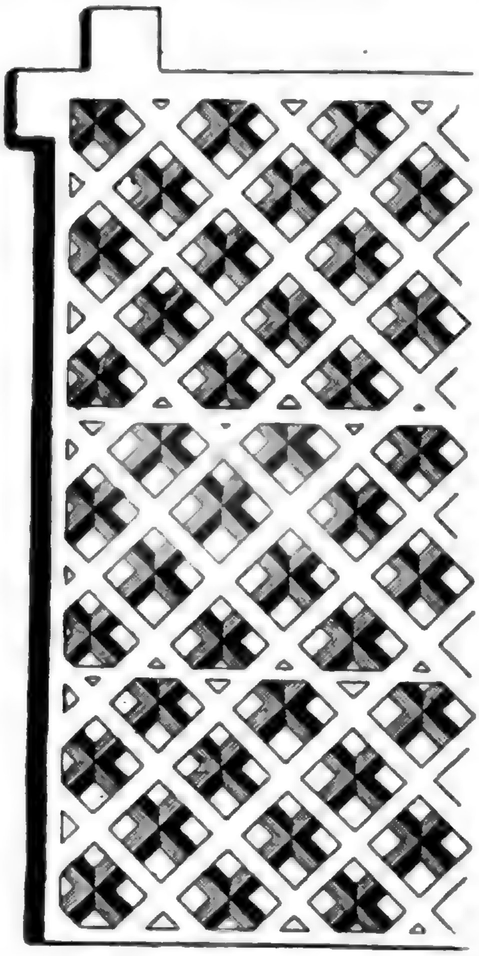

FIG. 4.—Plan Correns Double Grid.

In the latest form of Mr. FitzGerald's lithanode cell, weight is reduced by making the support of a light double frame of copper wire, protected from the action of the acid by dipping it first in soldering fluid and then in molten lead.

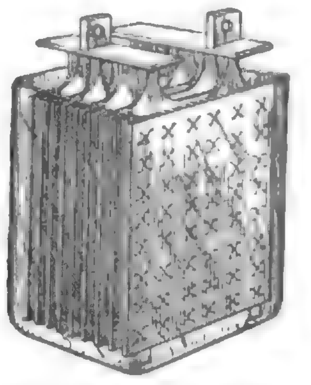

FIG. 5.—"Roberts" Cell, Complete.

The other improvements fall into two principal divisions: (*a*) Those which have for their object the retention of the paste on the plate, and they may be classed under four headings; (*b*) those intended to provide better connection between the support and the active material.

a. The Retention of the Paste.—1. The plate is not perforated, but grooves or recesses are made on the surface; or it is cast with projections from it, so as to afford a lodgement for the active material.

The Tudor plate is a familiar instance of this type, which has the advantage that the support gradually gets "formed," and supplies active material to replace that lost in the working of the cell.

In the new 1890 pattern E.P.S. plate, an early form, introduced originally by Swan, has been resorted to. The plate is grooved, but instead of the grooves being vertical, as in the Tudor plate, they are horizontal, and the ridges between the grooves curve slightly upwards towards the surface of the plate, forming a lodgement for the paste.

2. The support is some form of "grid," that is, is perforated with holes, as in the old pattern E.P.S. plate, and the Julien grid, Fig. 2.

A great many varieties of this form of plate have been suggested, and the apertures have been made by casting the grid in a mould, and by punching. Their form has been cylindrical, barrel-shaped as in Messrs. Drake and Gorham's positive plates, shaped like two cones joined at the apices, and to give greater security the perforation has been made to expand again just at the junction of the apices.

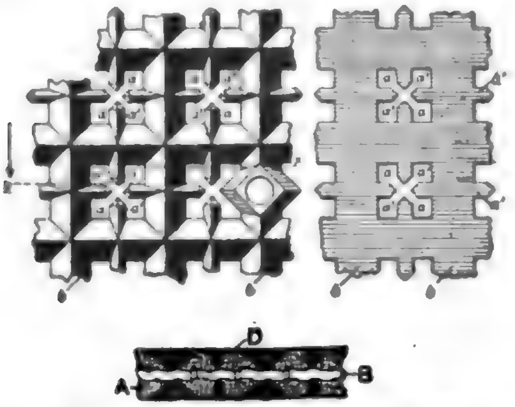

FIG. 6.—"Robert's" Cell: Detail of Plate.

The construction of a mould, to produce a perforation expanding inwardly, is a matter of difficulty, and therefore the grids are sometimes cast in two halves and subsequently joined, as in the Gadot cell, Fig. 3. In the Correns cell, Fig. 4, much used in Germany, the grid takes the form of a double lattice.

3. The active material is enclosed in a perforated conducting retaining vessel.

In this case, also, the devices resorted to have been very numerous. Plain or corrugated sheets of lead have been taken and folded into boxes, either before or after applying the paste.

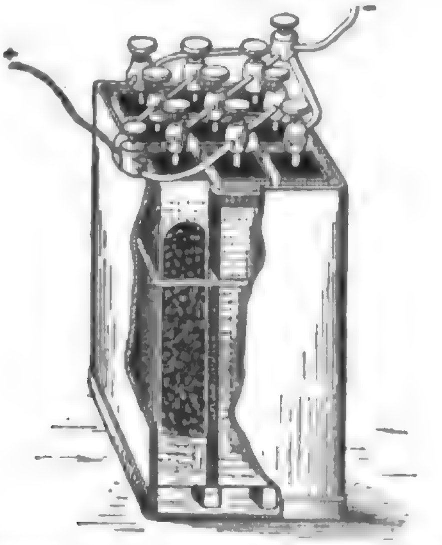

FIG. 7.—Tommasi Cell, Corner cut away to show Internal Arrangement.

In the Roberts cell, Fig. 5, two grids are taken, pasted on one side, and then united to form a plate with the paste inside, Fig. 6.

In Dr. Tommasi's multitubular cell, Fig. 7, the retaining vessel may be constructed of metal, but is usually of some non-conducting material, and so comes under the next heading.

4. The enclosing vessel or plates are made of some non-conducting material, or some inactive material is packed between the plates, to prevent short-circuiting, and retain the active material.*

In France the plates have been covered with perforated sheets of celluloid; Reynier brought out what he called an "elastic cell," specially designed for use on torpedo-boats. When tried in 1886, on board "La Gymnote," it was not a success, and the alkaline copper cell was preferred to it. Since then, however, the construction has been much improved, Fig. 8. Each cell, according to improvements effected in 1889, is composed of one positive, two negative plates, and four porous partitions held together, as shown by a frame consisting of two end plates connected together by corrugated strips of metal, which have sufficient elasticity to enable them to expand and contract with the alteration in volume of the plates caused by charge and discharge, Fig. 9.

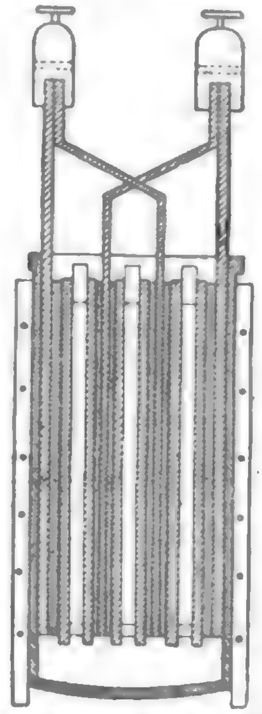

FIG. 8.—Reynier Element, Side View.

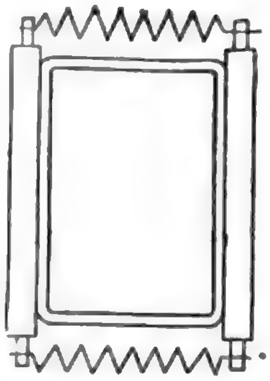

FIG. 9.—Reynier Element: Plan of Compressing Arrangement.

In this country Mr. Barber-Starkey has tried filling in between the plates with a mixture of plaster of Paris and sawdust; Mr. Fuller uses porous pots; and in the United States, in the Pumpelly battery, cellulose, or wood pulp, is used to separate the plates which are arranged horizontally, as in the Atlas cell, Fig. 10.

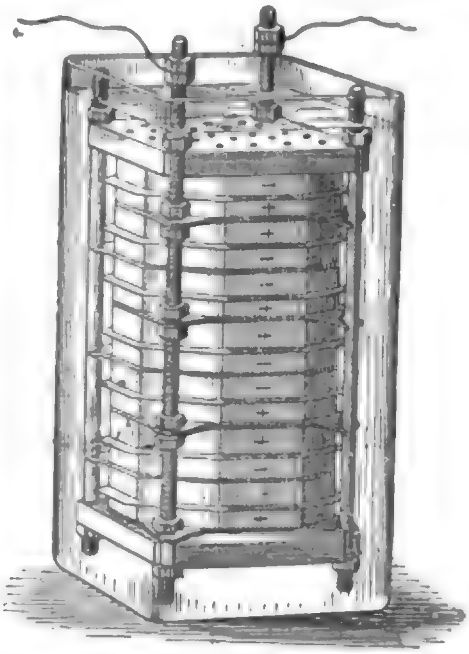

FIG. 10.—"Atlas" Cell.

(Continued on page 541.)

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* The improvements under this heading are equally applicable to cells of the Planté type; but as they are more frequently applied to cells of the Faure type, I refer to them under this heading.

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ADVICE RE THE PALACE EXHIBITION.

It is not often that we find ourselves thoroughly in accord with Colonel Gouraud, but his advice to exhibitors at the meeting in connection with the Crystal Palace Exhibition was sound and to the point. We had previously pointed out that at every exhibition of repute some firm or firms had laid a solid foundation for a reputation and for business abilities that rapidly led to increase of business and to fortune. Colonel Gouraud merely completed our suggestion by expressing in plain language the fact that a good exhibit requires a certain expenditure of money. There is, however, one other point which is worthy the closest attention. A day will be fixed for the opening of the exhibition. Already rumours are current as to the unreadiness of some of the exhibitors, and it is with these we wish to "wrastle." The only aim an exhibitor can possibly have nowadays is the necessity of keeping his trade or of increasing it. He exhibits because he cannot allow his rivals to gain a point in the race, and his returns are derived from various sources. In the first place, he may effect actual sales to customers who visit the exhibition. In the next place, by circulars handed to visitors and by explanations given to visitors, the exhibitor becomes acquainted with probable future buyers. The fad of having seen apparatus and knowing a firm are often vital points tending to direct orders in specific directions. Lastly, there is the wide advertisement to the four quarters of the globe given of apparatus by the descriptions which appear in the various papers. If we say that we intend to describe this exhibition from start to finish—and we do say so—it will be found that our contemporaries are bound to do likewise. They dare not lag behind in such a race. What, however, does all this mean to the laggards whose exhibits are incomplete a month or so after the opening ceremony ? They have missed the chances of obtaining customers during a time when the greatest interest exists ; they have failed to make themselves known as widely as they might, and they can never regain the lost ground. Ofttimes the excuse is: We are so busy ; we really have not time to exhibit. That excuse is good enough for a third or thirtieth rate exhibition, but not to one in the national home of exhibitions, to one devoted entirely to electrical matters, to one held just at a time when the widest vista of work ever opened to the eyes of electrical engineers appears before them in the glimpses that can be seen of the immediate future. We would urge upon every exhibitor, then, the importance of being ready at the time of the opening. Firms that are too busy to advertise, too busy to exhibit, too lazy to come up to time, are unworthy of support, and the sooner they are relegated to the background the better. Those firms having a reputation to make, or a desire to retain one they have made, should not pretend to be in the position of "don't care." They exist to do business, and if they are too high and mighty in their opinions customers had better—far better—go elsewhere.

Fortunately, there are, as yet, very few electrical firms who take this tone. There are one or two who imagine the world must wait upon them because they have been lucky in securing a certain amount of orders hitherto. Such firms must die a natural death, and will not survive the keener business spirits for many years. Those who seize the opportunity now offered will, we should imagine, never regret it. They have the chance of making their mark at a far more favourable time than those who were so active in 1882. Black Friday for electrical engineering has come since 1881-1882, and, so far as can be judged, has gone for good. There cannot again be such a rush of blind speculation, of Stock Exchange gambling, but there may be so vast an increase of work that it appals one to attempt to describe the possibilities for an enterprising firm. Once more to reiterate our caution. Be ready in time, if only to obtain the praise of the daily press. Every exhibitor should know that after a few short articles in these papers the whole subject will be practically dropped, and especially so if a turn of the political wheel should bring about some interesting political topic. The exhibits should be worthy the firms' reputations. Explanations should be forthcoming whenever a visitor turns up. Nothing is more annoying than to find some interesting piece of apparatus on a stand with no one at hand to explain its uses and mode of working, and yet more often than not visitors have to pass by with no more information than can be obtained from studying the external framework of a machine. At the Crystal Palace we must have nothing of this sort. A niggardly policy should be eschewed, and the exhibit should be ready at the opening.

LITERATURE.

A First Book of Electricity and Magnetism for the use of Elementary Science and Art and Engineering Students, and General Readers. By W. Perren Maycock, M.I.E.E. Whittaker and Co., London. Price 2s. 6d.

In deciding the value of a book it is necessary to look at it from the standpoint from which it was written. Mr. Maycock is more or less connected with the Science and Art Department, and necessarily his mind takes a bias in the direction of this department's labours. As a first book for such students as have to pass examinations, it is admirable. The statements are clear, accord with the authorities, amply illustrated, and the information given is driven home by a series of questions given at the end of each section.

Electricity Treated Experimentally for the use of Schools and Students. By Linnæus Cumming, M.A. Third edition. Longmans, Green, and Co. Price 4s. 6d.

A book that has stood the test of three editions hardly needs a godfather. An attempt is made to cover a very wide field in an elementary manner, and undoubtedly the student is led gently and pleasantly onwards. The alterations to this edition are principally connected with the more modern practical developments in apparatus, which are simply described and freely illustrated. The subject is treated under four sections, dealing respectively with Magnetism, Frictional Electricity, Voltaic Electricity, and Thermo-Electricity, with appendices on "Units" and "Table of Sines, etc."

CORRESPONDENCE.

"One man's word is no man's word
Justice needs that both be heard."

VOTES OF GAS SHAREHOLDERS.

Sir,—At meetings of local authorities the question is from time to time raised whether members interested in gas undertakings are entitled to vote or take part in discussions upon electric lighting matters. It may be useful, therefore, to the electrical industry to know what the law on this subject is. Mr. Sydney Morse has had occasion to take counsel's opinion upon the point, and as I have obtained the permission of his clients to publish the opinion which he has obtained from Mr. R. S. (now Mr. Justice) Wright, I enclose it herewith, and trust that its publication by you may help to prevent the continuance of the injustice which is now frequently done to electrical companies by representatives of gas interest.—Yours, etc.,

London, E.C., Dec. 2, 1891. E. Garcke.

OPINION.

The Urban Sanitary Authority of ——— is the Corporation acting by the Council (see s. 6 of the Public Health Act, 1875), and consequently the present question turns on the construction of s. 22, sub s. (3) of the Municipal Corporations Act, 1882. In my opinion those members of the Council who are shareholders in the gas company have a direct pecuniary interest in the question, whether or not the Council shall give their consent to the application by the electric light company for a license under 45 and 46 Vict., c. 56, s. 3, and such members are not entitled to vote on the question or to take part in the discussion of it. No penalty is attached to a breach of s. 22, sub s. (3), and all that can be done in order to prevent such members from voting will be to get some member of the Council to draw the attention of the Mayor to the fact that the votes in question ought not to be received, and will be invalid. See rule 10 of the second schedule to the Municipal Corporations Act, 1882.

(Signed) R. S. Wright.

45 and 46 Vict., ch. 50, s. 22.

(3). A member of the council shall not vote or take part in the discussion of any matter before the council or the committee in which he has directly or indirectly, by himself or by his partners, any pecuniary interest.

ELECTRIC VANS.

Sir,—Can your readers inform us whether it is yet practicable to convey a van, which with its contents would weigh about five tons, over a common road for 35 miles by an electric motor and accumulator? By "practicable" we mean at an average speed of not less than five miles an hour, at a cost considerably less than that of horses, and without recharging the accumulators during the journey. We shall be glad to have any proposal on the subject.—Yours, etc., Hazell, Watson, and Viney, Limited.

1, Creed-lane, E.C., Nov. 30, 1891.

SECONDARY BATTERIES.

(Concluded from page 539.)

b. Improved Connection Between the Applied Oxide and the Support.—With this object the support has been well rubbed with carbon before applying the paste, and the addition of carbon to the paste in some form has been frequently recommended, as, for instance, kneading the oxides into a paste with lead acetate.

In the Tudor cell, Fig. 11, the positive plates are first treated by Planté's process, to coat them with a layer of crystalline electrolytic peroxide. The grooves are then partially filled with a paste of peroxide of lead, and pressure is applied to the ridges to expand them, and partially close the mouths of the grooves, Fig. 12.

The casting or welding of the applied oxide to the plate has also been tried, and to overcome the difficulty of getting the substances to blend into one another, caused by the great difference in their melting point, it has been suggested to fill the portion of the mould usually occupied by the support with some reducing agent, such as carbon mixed with nitre, so that when the fused oxides are poured into the mould they will be reduced in part to metallic lead, which will assume the place and shape of the carbon core, while the remainder forms the active material.

General Improvements.—Besides the improvements in what may be called the manufacture of the plates, or electrodes proper, various devices have been resorted to with the view of diminishing the resistance of the lugs, and securing better contact between plates of the same sign, such as making connection by tinned copper rods passed through holes in the lugs. Lead is afterwards cast round the copper, so that it is screened from the action of the acid.

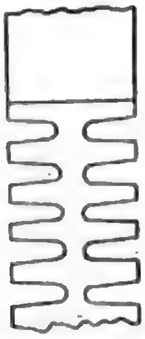

Fig. 11.—Tudor Plate: Side View, Empty.

Some attention has also been given to the question of the best electrolyte to use, some advocating the use of acid of density 1,150 to 1,180, while others recommend a density 1,200 and over. The addition of small quantities of some salt of the alkalies, such as sodium sulphate or carbonate, has been recommended by Mr. Barber-Starkey and others, with a view of reducing sulphating; and Dr. Paul Schoop has brought out a successful gelatinous electrolyte by adding one volume of dilute sodium silicate, density 1·180, to two volumes of dilute sulphuric acid, 1·250.

In order to prevent short-circuiting between the plates by the material dislodged in working, they are now either slung, or rest on supports, which are so placed that the formation of a layer of mud between them is prevented.

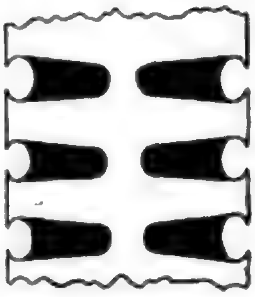

Fig. 12.—Tudor Plate: Side View, Empty.

The equalisation of the chemical action over the surface of the plates has also been attempted, and in the Schoop cell the current enters at the top of one set of plates and leaves from the bottom of the others. The plates also are widely spaced now as a rule, the proportion of acid to plates has been increased, and little alterations are constantly being made to secure the free circulation of the electrolyte essential to regular working.

The Chemistry of the Acid.

Although so many different modes of manufacture and preliminary treatment have been resorted to, all the batteries, so far as I am aware, which depend for their action on the couple formed between lead and lead peroxide in dilute sulphuric acid, exhibit the characteristic peculiarities noticed by Planté in his cell—namely, the high initial E.M.F. of a freshly-charged cell; the fall of E.M.F. on breaking the charging circuit, with corresponding rise on breaking the discharging circuit; the very rapid fall towards the end of discharge which occurs earlier, the more rapid the discharge is, and is not due to the exhaustion of the active material, as after a rest a fresh discharge can be obtained.

As the defects—namely, sulphating and buckling—which have retarded the introduction of reversible lead batteries are also common to the two types, it appeared possible that they were due to the same causes which produced the variations in E.M.F.; therefore, as the work of Dr. Oliver Lodge[*] in 1883, and of Miesel[†] in 1888, had shown that the causes of the variation must be sought either on the lead plate, or in the acid next it, and the chemistry of the plates afforded no explanation.[‡] I last year, with Dr. Armstrong's advice and assistance, undertook the investigations of the reactions occurring in the acid.

Planté had considered that the peculiarities in E.M.F. were due to the formation of peroxides in the acid, and showed that the conditions existing in a cell were favourable to their production, since in voltameters with lead electrodes they were formed in greater quantity than in those with platinum. He also noticed that, immediately on the cessation of the charging current, there was often a small evolution of gas from the peroxide plate; this evolution he ascribed to local action between the peroxide and the subjacent lead.

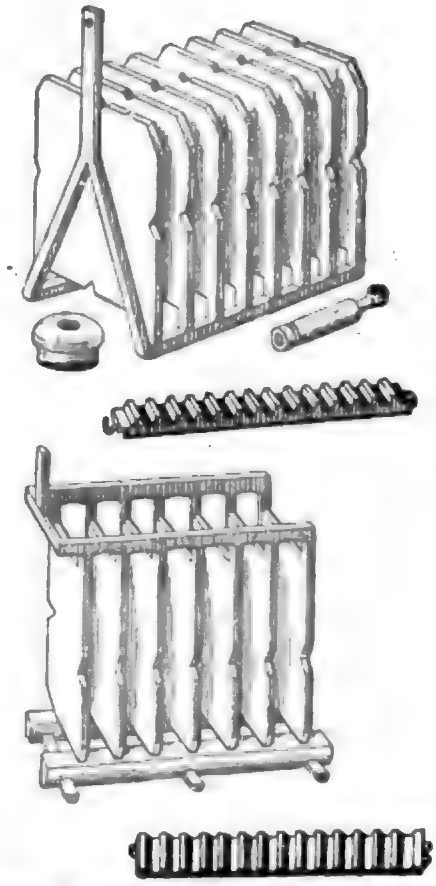

Fig. 13.—Plates of Oerlikon Cell Separated.

Commenting on this, in their little book, "The Chemistry of Secondary Batteries," Messrs. Gladstone and Tribe point out that the gas is oxygen, and cannot be due to local action, since the gas was evolved whether the peroxide was removed from the supporting plate or not. The application of heat increased the evolution of gas, and the gas was oxygen. Testing the acid between the plates, they always found traces of something which decolourised permanganate, and might, therefore, be hydrogen dioxide or ozone.

Although a very large amount of work has been done on the electrolysis of sulphuric acid solutions, and the general character of the change in the nature of the products formed as the strength of the solution is varied, is well understood, the only references I was able to find to any examination of the acid in a battery were those just given; and, therefore, I have ventured to bring the results of my own experiments before this society, not because I consider them a final solution of the difficult problem of the chemistry of the cell, but because I hope that the study of the changes occurring in the electrolyte may help to elucidate some points which are at present obscure.

---

[*] Cantor lecture.

[†] "Monatschafte für Chemie," viii., 713.

[‡] For references and a summary of the principal work done on the cell, see the *Electrician*, vol. xxvii., No. 682, p. 165; No. 692, p. 437.

And now it may be as well to refer briefly to the work which has been done in sulphuric acid.

In 1878, Berthelot[*] discovered persulphuric acid ($H_2S_2O_8$), and brought forward evidence to prove that it is the primary product of the electrolysis of sulphuric acid solutions, and that the hydrogen dioxide—which from Faraday's time has been well known to be present in sulphuric acid after electrolysis—is really due to the action of this body on the acid. The products of electrolysis vary with the strength of the acid, 40 per cent. acid (density 1,300) yielding practically no hydrogen dioxide, while below and above that strength it is present in varying proportions. High-current density and an electro-negative condition of the electrodes favours their formation.[†] Persulphuric acid is an unstable body, and begins to decompose as soon as the current which has given rise to it is stopped, and its decomposition is accompanied by the formation of hydrogen dioxide, unless the sulphuric acid is too dilute. Hydrogen dioxide is also unstable when concentrated, but a weak sulphuric acid solution of it is comparatively stable, and the stability increases the less hydrogen dioxide it contains, therefore this body is found in estimable quantities long after the persulphuric acid which gave rise to it has disappeared. Persulphuric acid is at once decomposed by spongy metal, such as platinum black, by heat with evolution of oxygen,[‡] and resembles hydrogen dioxide in these reactions, and in releasing iodine from potassium iodide, but, unlike it, has no action on permanganate of potassium or peroxide of lead. The effect of electrolysing a sulphuric acid solution of hydrogen dioxide is simply to increase the rate of the decomposition occurring spontaneously if a weak E.M.F. is used;[§] but on increasing the E.M.F., though the rate of decomposition is increased, a little persulphuric acid is re-formed. Subsequent workers have in the main confirmed Berthelot's conclusions. To the oxidising oxygen in the products of the electrolysis of sulphuric acid Berthelot gave the name of "active oxygen," and as they pass one into the other, and for most purposes connected with a battery it is not necessary to discriminate between them, I have retained it.

EXPERIMENTS AT THE GENERAL POST OFFICE.

That the nature of the electrolyte affected the behaviour of the cell, was evident from information received from Mr. Barber-Starkey with respect to the effect of the addition of sodium carbonate; and it seemed possible that the different behaviour of cells containing this substance was due to its catalytic action on hydrogen dioxide, which is known to be exceedingly unstable in the presence of a trace of alkali; and hence a comparative study of the reactions occurring in cells containing ordinary dilute sulphuric acid, and in those which had been treated on Mr. Barber-Starkey's plan, seemed likely to elucidate the causes of the sulphating during rest, and the high initial E.M.F.—the two features most affected by his treatment.

Mr. Preece most kindly aided the investigation by allowing experiments to be carried out at the General Post Office, where one-half of the secondary cells contain 1 per cent. of sodium sulphate, and the other half ordinary dilute acid, density 1,180. He also put at my disposal the records of the behaviour of the cells, and they proved that there was much less sulphating with sodium sulphate, as shown by the density of the acid never falling to the same extent as in the plain cells. The following readings taken from short-circuited cells with badly broken plates illustrate this. In two cells containing ordinary dilute acid the density of the electrolyte had fallen to 1,100, while, according to the last readings before the short circuit occurred, it had been 1,170 and 1,180 respectively; while in two sodium sulphate cells the density had only fallen to 1,180 from 1,200 under similar circumstances.

This was strong evidence in favour of the hydrogen dioxide formed in the working of the cell being appreciable in quantity, since its sulphating were only due to local action between the support and the paste, there does not appear any reason why the addition of sodium sulphate should affect it.

Whenever the cells were tested they were always found to contain "active oxygen," which was due to the presence of persulphuric acid and peroxide of hydrogen in varying proportions. During charge persulphuric acid is the main constituent; during discharge the quantity of hydrogen dioxide gradually increases; while in a cell which has been at rest some time there is very little except hydrogen dioxide to be found.

In addition to the tests made on the cells in the electric light and telegraph batteries, I studied the formation of the "active oxygen" during charge and discharge on some cells which were kindly set apart for my special use. The "active oxygen" forms at once on the passage of the current, decreases slightly, and then increases to a little above its first value. Starting either charge or discharge always causes an initial increase, except in the case of cells which have been long idle, when there is a diminution due to the decomposition of the excess of hydrogen dioxide in the acid.

To test whether electrolysed acid was able to reduce pure peroxide of lead, two equal lots of peroxide were taken by weighing one against the other, and put in two flasks. On to each, 100 c.c. of acid, from next the positive plate of a cell at full charge was poured, and this caused the evolution of oxygen, which continued slowly for some days. At the end of a fortnight the amount of peroxide of lead in each sample was estimated, and it was found to have decreased from 97·4 per cent. to 93·94 and 94·04 per cent respectively.

This appears to explain the well-known deleterious effect of rest on a cell; for although persulphuric acid itself does not reduce peroxide of lead, it forms hydrogen dioxide on standing, which is capable either of oxidising the lead plate to litharge, or of reducing the peroxide plate to the same substance. In each case the litharge is converted into sulphate by the sulphuric acid.

In an ordinary cell in good order the amount of "active oxygen" is small, varying in quantity from about 0·01 gramme to 0·02 gramme per litre; but this means that in a 45-pint cell (the size used at the Post Office) there was always sufficient to convert from 3·25 grammes to 7·5 grammes of peroxide of lead into sulphate, or to undo the work of one to two ampere-hours' charge.

This is not a serious matter if the cells are kept working, as the peroxides are being continually broken up with each reversal of the current, but if the cells stand idle the plates get sulphated, and the amount of "active oxygen" formed in the next passage of the current shows a marked increase.

The figures just given do not represent the total amount of "active oxygen," since the acid absorbed by the plates cannot be tested; but as the acid has more oxidising power the nearer you get to whichever is the positive plate, except at the commencement of discharge, and the total quantity of "active oxygen" increases rapidly soon after breaking circuit, it seems fair to assume that this increase is due to diffusion from the plates of acid which has more oxidising power than that in the body of the cell.

This increase is followed by a decrease which is rapid at first, and then gradually gets very slow, and practically ceases while there is still a fair proportion of "active oxygen" left in the cell.

In the sodium sulphate cells the amount of the oxidising agent was usually less than in the plain cells; and the amount of hydrogen dioxide was always so, unless the battery had been at rest for some, when the conditions were occasionally found to be reversed. This, I suppose, is due to the proportion of "active oxygen" in the form of hydrogen dioxide, at the moment of stopping the current, being greater in the plain than in the sodium sulphate cells, while the latter contain more persulphuric acid. In both cells the hydrogen dioxide present at the time of stopping the current will be reduced on the plates, sulphating the surface, and more or less screening them from further action; but as the sodium sulphate cell contains more persulphuric acid, the subsequent formation of hydrogen dioxide will be greater in it than in the plain cell. As far as I could discover, sodium sulphate has little or no action on the acid unless it is added during electrolysis, or to acid which has just been taken from a cell through which a current is passing.

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[*] Berthelot. (*Compt. Rend.* 90, 269-275.)

[†] Richarz. (*Ann. Phys. Chem.* [2] 31, 912.

[‡] Berthelot. (*Bull. Soc. Chim.* [2], 34, 78-81.)

[§] Berthelot. (*Compt. Rend.*, 95, 8-11.)

The Pink Colour of the Acid.—It has often been noticed that during charge, particularly with new cells, a pink colour starts from the peroxide plates, and gradually spreads over towards the lead plates, fading away, however, before reaching them. This pink colour was referred to by Mr. Crompton at a meeting of the Institute of Electrical Engineers on 13th December, 1890, and its origin gave rise to some discussion; so as the acid in many of the cells at the Post Office was pink, I tested it by concentrating it down, neutralising with sodium carbonate, and then igniting on platinum foil, and always got the characteristic green of manganese.

However, lest the manganese should have come from some other source than the pink acid, I compared the absorption spectrum of the acid with that of a solution of potassium permanganate of the same shade of pink, and found they both gave the characteristic bands in the green, Fig. 14. I also found that, using two strips of platinum as electrodes in a solution of manganous sulphate, or any two strips of lead in dilute acid, gave the same colour and the same absorption bands, provided the electrodes were sufficiently far apart to prevent reduction by the hydrogen evolved by the negative. This result was important, for it is well known that the pink colour disappears from the acid in a short time if it is taken from the cell, and as persulphuric acid has no action on permanganate, but hydrogen dioxide decolourises it, this disappearance of the colour shows that the latter is formed.

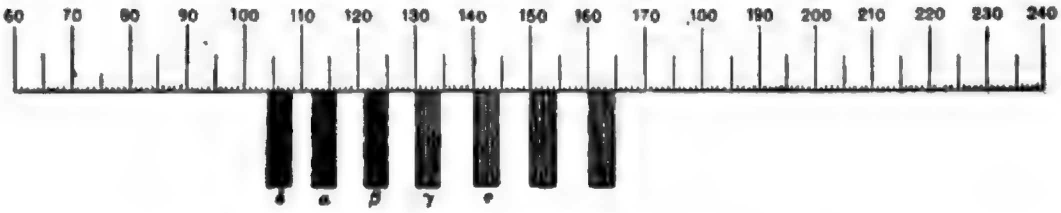

Fig. 14.—Absorption Spectrum of Potassium Permanganate.

The Effect of Hydrogen Dioxide on the E.M.F. of a Cell.—The presence of hydrogen dioxide having been thus proved, both directly and indirectly, its effect on the E.M.F. of the cell was tested. This was done by using strips of lead packed tight into small porous pots, with peroxide of lead to represent the peroxide plates, and using plain strips as the lead plates. A solution of pure sulphuric acid, density 1,180, was used as the electrolyte. The E.M.F. of the couple was taken by the deflection method, and then a drop or two of hydrogen dioxide was added to the acid, which produced a great diminution, or even reversal, of the E.M.F.

The effect of introducing hydrogen dioxide into the body of the peroxide paste was also tried, with a view of reproducing, if possible, the conditions of a cell which is started discharging directly the charge is completed, and in which the "active oxygen" would be accumulated at the positive plate, leaving the lead plate free, and I found that there was a slight increase in E.M.F.

Thus the variations in E.M.F. appear to depend on which plate hydrogen dioxide is formed at. When present at the peroxide plate it causes a rise, but when diffused through the acid and present at the lead plate it causes a lowering of the E.M.F.; and the rise in E.M.F., sometimes noticed on starting the discharge of a cell which has been at rest (mentioned in Prof. Ayrton's paper, J.I.E.E., 1890, p. 572), is probably due to the electrolysis and decomposition of hydrogen dioxide, for, in a cell which has been long idle, practically the whole of the "active oxygen" is due to this body.

CONCLUSIONS.

From the same faults appearing in batteries of such different construction, and judging also from the results of the experiments recorded in this paper, it would appear that the troubles occurring in batteries are due rather to causes arising in the working than in the manufacture. What is required is some substance which can be added to the acid to check the formation of the oxidised bodies in it, which cause sulphating without at the same time injuring the plates in other ways.

Nearly all the "forming" baths which have been introduced are baths in which hydrogen dioxide would be broken up as soon as formed, and perhaps in some modification of them the electrolyte of the future will be found; though, since the products of the electrolysis of sulphuric acid vary with the strength of the acid and the current density, no hard and fast rule can be laid down for the treatment of cells.

In cells containing acid below density 1,200, in which the proportion of "active oxygen" existing as hydrogen dioxide is high, the addition of 1 per cent. of sodium sulphate, or similar substance, is likely to prove beneficial, particularly if the work of the cells is intermittent. As the strength of the acid is increased, however, and the conditions are more favourable to the stability of persulphuric acid, less hydrogen dioxide will be produced, and there is more chance of the alkali released from the sodium sulphate during electrolysis damaging the plates.

Also, Dr. Marshall has succeeded in preparing pure persulphuric acid, and has shown this year that it forms salts with the alkalies which are very stable; and what the effect on a cell of the formation of sodium persulphate in it would be, is quite unknown. Although the formation of peroxides in the acid does not apparently account for the great gassing and sudden loss of charge sometimes observed, still we have seen that makers are reverting to Planté's process of manufacture, or modifications of it, and we may find that in this case also he was right, and that it is to the electrolyte we must look if we wish to find the means of materially improving the lead reversible battery.

In conclusion, I must thank the firms who have assisted me in the compilation of this paper by supplying information in response to circulars sent out.

MAGNETIC RELUCTANCE.*

BY A. E. KENNELLY.

(Concluded from page 519.)

An examination of reluctivity curves naturally suggests the question as to whether there is really a strict linear relationship between H and ρ. In other words, whether the divergences of the observation curves from geometrical straight lines can be fairly ascribed to errors of observation, allowing for the influences of residual magnetism.

First confining the enquiry to the ascending reluctivity line—that which is geometrically consequent upon Frölich's formula and also under special interpretation with Lamont's formula—the agreement of the plotted observations with a straight line between the neighbourhood of the critical H and H = 150 is often so good as to intimate the existence of a definite linear relationship. It is generally to be found, however, that beyond 150 C.G.S. units of H, the line bends downward until all hope of rectilinearity is lost. That is on the simple circuit theory of reluctance. If, however, we introduce an amendment into the definition of reluctance borrowed from the vein or polar theory, the rectilinearity appears to be nearly sustained for a much greater distance. Experimental observations of the reluctances in circuits of the magnetic metals under powerful magneto-motive forces are yet very scanty, but judging from the results of Ewing and Low the reluctivity of wrought and cast iron on the amended definition appears to be a linear or at least nearly linear function of the force as far as H 25,000 and H 11,000 respectively, the limits of the quoted measurements.

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* Paper read before the American Institute of Electrical Engineers, October 27, 1891.

The graphs of these measurements are given in Fig. 10. The observations run from H 3,630 to 11,200 for wrought iron with an isolated observation at H 24,500 in a separate instance, the similar series for cast iron running from 3,900 to 10,610 units of H. The linear relationship is very fairly maintained and the lines prolonged downwards nearly strike the origin. It is to be observed that at the limiting observation for wrought iron its reluctivity is nearly 20 per cent. greater than that of air or of the air-pump vacuum.

According to the simple circuit theory, the reluctance is of course the ratio of the magneto-motive force to the flux and the reluctivity this quantity locally reduced to the unit of volume. On the vein theory, however, which as we have seen distinguishes the vein flux from the magnetising flux superposed thereon, the conductivity of a mass of iron is the conductivity of the iron itself added to that of the space it occupies, and consequently applying the vein theory to the magnetic circuit we have the apparent reluctance of the iron mass as the joint reluctance of two paths in multiple arc, one through the iron itself and what might be called its metallic reluctance, the other through the reluctance of the space occupied by the iron, and the removal of the iron would leave this latter unaltered The difference between the apparent and metallic reluctance is inappreciable while the latter remains small, that is generally speaking when H is below 150, a limit rarely exceeded, and consequently the question does not present itself under practical conditions, but for large values of H, the difference is considerable and the metallic reluctance approaches the linear relationship with H while the apparent reluctance deviates considerably from it.

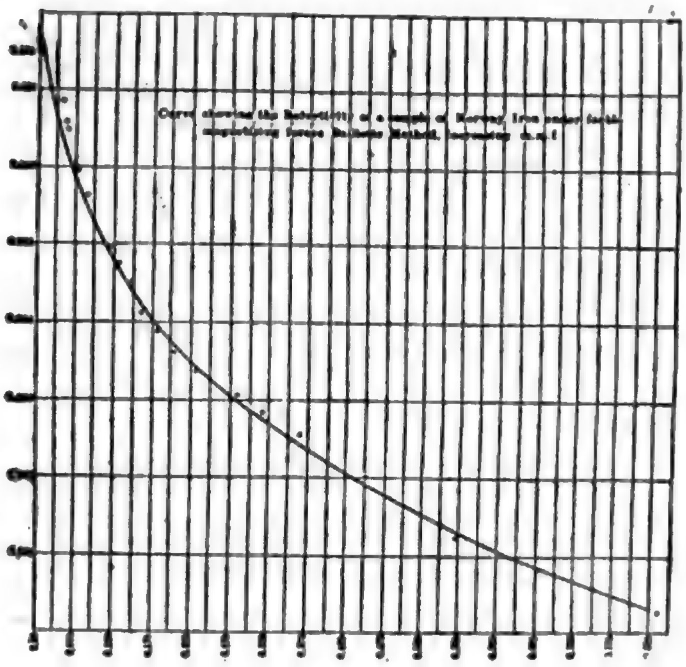

FIG. 9.

These assumptions from the vein theory while they may be convenient are somewhat artificial for they postulate that the space reluctance of a given volume of air is not altered when the volume is occupied by iron. This may not be impossible but it is difficult to imagine any reluctance mechanism of ether that would remain undisturbed by the introduction of a massive substance. On the other hand, while the vein theory imposes this principle not touched upon by the circuital hypothesis, it explains very satisfactorily the fact now apparently beyond dispute, that while iron can be saturated there is no limit yet attained to the flux density that can be made to pass through it. Ewing's results give no limit at the observed flux density of 45,350 C.G.S., nearly three times the flux density at which iron is commonly worked in practice, while at the same time they indicate a limiting value of magnetisation long before that density is reached. Following the vein theory, the polarisation of the iron is then complete and the intensity of magnetisation or magnetic matter per unit cross-section of veins finds its maximum, so that, while the total flux can go on increasing indefinitely, it can only do so by adding to the permeating field flux, the vein flux having reached its full limit. It is not impossible to represent the observed condition of affairs by the simple circuit theory, but the mental picture is not so clear. It would be possible, for instance, to imagine that the molecules of all substances transmitted the stress flux with the same, or almost the same, facility as the ether surrounding them, but that in the magnetic metals they exalted the stress in transmission. Maxwell supposed that the iron molecules were so constructed that they could take part in the ether spin that might constitute the stress, and, if so, by adding to it their momentum of revolution, they could augment its value. There would be then, perhaps, at a certain stress, a speed of revolution which the iron molecules would not exceed, and their reinforcement would be at a maximum, while for stresses enormously greater than this the molecular augmentation would be lost in comparison with the strength of field, and the iron molecules would in the aggregate behave almost like the motionless transmitters of other substances. The consequences of this conception seem more complex, exen if more nearly true.

Turning now to the descending curve of reluctivity between the initial and critical values, closer examination will show that here at least the linear relation is only an apparent one. The descent is so steep that on the scale of projection it appears nearly straight, but when magnified it has a distant curvature. Rayleigh* and others have shown that for small degrees of H the permeability commences with a definite steady value, and this being the case it would be impossible for the reluctivity—the reciprocal of that permeability—to be linear towards H. Series of observations covering with sufficient detail the range of H from zero to unity are apparently few, and Fig. 9 gives the plotted values of the reluctivity on an enlarged scale, observed by the writer for a sample ring of Norway iron. The descending line has a marked curvature approximately logarithmic, that would be almost inappreciable, however, on the scale of the other reluctivity diagrams.

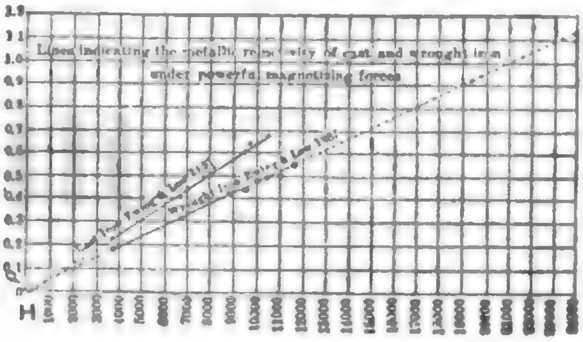

FIG. 10.

Even, however, if we admit that there exists a linear relationship between H and ρ beyond the critical point, that is to say, if the experimental results justify the belief that Frölich's formula is not merely an empirical one, we are scarcely entitled to attribute to this relationship an intrinsic physical signification. It may enable us to grasp the salient features of the magnetic circuit by the re-establishment of Ohm's law, but the relationship is more likely to be the consequence of a more remote fundamental agency than to be significant of any physical condition resident in metallic reluctivity itself. This is for the reason that the increase of flux under M.M.F. in a magnetic circuit due to the presence of iron is more probably owing to an assisting M.M.F. set up in that iron under stress than to any change in the latter's reluctance, and the removal of the initial source of M.M.F. from the circuit still leaves some M.M.F. active as residual magnetism.

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* *Phil. Mag.*, March 1887.

The case is similar to that of an electric circuit containing a polarising electrolyte. It might be more simple to ignore the counter E.M.F. of polarisation, and to regard the resulting diminution of current as the result of an extra resistance whose value might be tabulated or possibly even reduced to simple laws. So again in alternate-current circuits, it is often more convenient to speak of a resistance coil with inductance as possessing an impedance greater than its ohmic resistance and to determine the flow of current on the basis of impedance calculated to the original E.M.F., whereas the direct and fundamental method would be to keep the resistance at its true value and determine the current by allowing for the counter E.M.F. of inductance in quantity and in time.

Retaining, then, the latter analogy, we may say that flow in an electric circuit is subject to Ohm's law simply when the E.M.F. is constant, but when the effective E.M.F. varies periodically, the resistance has to be increased by a definite amount depending on the inductance and the manner of fluctuation in order to obtain the correct effective current under those conditions. Similarly that the flux in a simple magnetic circuit of air or vacuum is subject to Ohm's law, but that if the circuit includes a magnetic metal, the reluctance in the formula has to be changed in a definite way depending on the quality of the metal and on the magnetising force in order to obtain the corresponding true flux density. The change in reluctance is the ideal connection of a shunt metallic circuit in parallel with the air circuit, and the reluctivity through the metal is nearly $a^1 - b^1 H$ for values of H below the critical and $a + b H$ for values beyond, with a little uncertainty in the vicinity of the critical point itself.

PURIFICATION OF WATER BY ELECTRICITY.

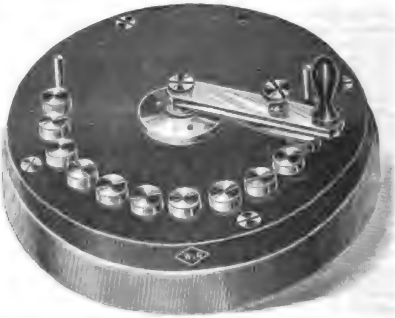
Webster's method of purifying waste water has, says the Berlin correspondent of the *Lancet*, been tested by Dr. Fermi in the Hygienic Institute in Munich, and he has communicated the result in the last volume of the *Archiv für Hygiene*.

The electrified waste water, he says, purifies itself in about 15 minutes. The dissolved organic substances are reduced by about one-half, and the suspended substances are either precipitated to the bottom by the ferric hydrate formed on the surface of the iron electrodes, or gather on the surface of the water. The smell of the water is perceptibly improved. The oxygen generated by the electrolytic decomposition of the water and the chlorine set free by the decomposition of the chlorides gather on the positive electrode, the ammonia developed by the separating of nitrogenous substances on the negative one. The method has two considerable advantages. The first is that very little iron is precipitated, and its removal is therefore not so difficult as in the case of water purified by chemical methods. The second is that the dissolved organic substances, which are not precipitated by any of the chemical methods hitherto applied, are at least partially got rid of by the electric current. The stronger the current the larger the surface of the electrodes, and the longer the electrisation lasts, the quicker and completer is the purification. The organic substances contained in a litre of water can be reduced by two-thirds in one hour by an electric current of 0·5 to 1·0 ampere with flat iron electrodes 80 cubic centimetres in size and five centimetres apart. The number of germs is thus diminished fifty or a hundredfold. The purifying effect of such current, however, is less reliable than that of the addition of 1 per cent. of lime, which completely frees the water of germs and keeps it free, whereas, in the electrified water the germs multiply again fivefold in 48 hours. Weaker currents, even when applied for a longer time, give no better results. In contrast to most of the known chemical methods some oxidisable organic substances are reduced in quantity by the electric current. Electricity seems not to realise the ideal of the purification of water, but it is certain to compete formidably with the chemical methods, and the method will probably be greatly improved.

TRADE NOTES—ELECTRICAL AND MECHANICAL.

CIRCULAR RESISTANCE.

We herewith illustrate a new form of circular resistance just introduced by Messrs. Woodhouse and Rawson. They may be had either 12 or 20 way, and are mounted on slate bases neatly fitted into wood frames.



ELECTRIC LIGHTING.

LECTURE AT HENDON.

On Monday evening last, Mr. Guss F. Metzger, A.M.I.E.E., lately superintendent of the Metropolitan Electric Supply Company's central station at Whitehall, but now on the staff of Messrs. J. E. H. Gordon and Co., gave a lecture at the Hendon Public Hall, which was entitled "Electricity in the Service of Man." Considering that a thick fog enveloped the neighbourhood in its damp clutches, and made locomotion, pedestrian or otherwise, a matter of difficulty, Mr. Metzger had a very fair audience. The hall was lighted by incandescent lamps of varied candle-power, and attached to a number of different fittings, the current being obtained from a vanload of accumulators outside the building. The chair was taken by Mr. W. Page.

At the outset Mr. Metzger went over the well-worn ground of the applications of electricity to man's use in the shape of the telegraph, telephone, electric bell, electro-plating, and so on, eliciting some laughter and much applause from time to time by the quaintness of his remarks. Having explained the different methods of producing electrical energy for lighting and other purposes, and alluded to the utilisation of water power in Ireland by Messrs. J. E. H. Gordon and Co., and having also referred to the Lauffen-Frankfort experiments, he went on to deal with the practical application of electric lighting for outdoor and indoor purposes. He said:

Where large areas have to be lighted outdoors, arc lamps are the most suitable. These can be had from 100 to almost any candle-power, and are now greatly used for street lighting. Arc lighting compared with gas is very cheap, as a few figures will show you. One thousand cubic feet of gas, costing 4s. 6d., gives a total power of 2,000 candles. Now what can we get for 4s. 6d. with the electric light? One pound of coal per hour burnt will produce electrical energy sufficient to light an incandescent lamp of 48 c.p. In the form of an arc lamp the same quantity of coal produces 288 candles. This means that we get six times as much light out of an arc lamp as out of an incandescent for the same amount of coal consumed.

Mr. Metzger then placed the following calculation before the meeting by means of the blackboard:

1lb. coal converted into gas = 17·2 c.p.
1lb. coal converted into incandescent light = 48 c.p.
1lb. coal converted into arc light = 288 c.p.

Five cubic feet gas will give 10 c.p. per hour.

1,000 cubic feet gas will give 2,000 c.p. per hour, costing 4s. 6d. Taking average at 3·3 watts per candle-power, and at 6d. per unit, we get

33 watts = 10-c.p. lamp per hour.
6,600 watts = 2,000-c.p. lamp per hour.
1,000 cubic feet gas is therefore equivalent to 6,600 watts.
6,600 watts = 6·6 units.
At 6d. per unit = 3s. 3d., against 4s. 6d. for gas.

In other words, if you want to light your streets by arc lamps you would get fully five times the amount of light you are now getting for the same price as you are now paying for gas. I say five times, as a certain allowance must be made for the renewal of carbons in arc lamps. These carbons could be renewed by a contract with the supply company, and by their men during the day when they are not wanted, as the machinery will be standing. The lights, moreover, can all be switched on and off simultaneously from the central station, thus doing away with the extra expense for gas-lighters. Arc lamps would have to be placed farther apart than ordinary gas lamps, the power given out being so much greater. A distance of 200ft. is about correct if the lamps are 20ft. high. If placed lower the glare is too much. They are therefore placed high, and at a good distance apart. I have now come to the application of electricity in such a way as will interest and concern you personally most—namely, the lighting of your own houses by the electric light. Many of you have no doubt looked and longed to have the light in your houses on account of its soft rays, its cleanliness, and its safety against fire risks, but have fought shy of it on account of the expense. It is the general belief that the electric light is expensive. This may have been so a few years ago, but the statement no longer holds good of electric lighting in the present day. When a house is supplied with current for lighting purposes a meter is fixed in the cellar, precisely as with gas, to register the amount of current used. Gas is charged by so much per 1,000 cubic feet, electricity by so much per unit of 1,000 watt-hours. The price per unit varies from 6d. to 8d., and more. To give you an idea of how much a unit is and how much you can get for your money I must tell you that an 8-c.p. incandescent lamp will consume in 30 hours' burning just about one unit, or it costs, roughly, ¼d. an hour per 8-c p. lamp. Gas would be about the same at the rate of 3s. 3d. per 1,000 cubic feet, not taking into account any oil and candles used. But it is not only the smaller cost of electricity compared with gas in the actual burning that must be taken into account. When a house is lit by gas a great amount of waste must necessarily occur. At dusk the servant goes round and lights the burners in the rooms all over the house, whether they are wanted for an hour or two or not. In the bedrooms the lights are left low, ready for turning up when dressing for dinner or going to bed, as the case may be, and in the winter months these lights are burning for hours before actually wanted. And why? Because unless it is done there is the bother of lighting it, to save which the gas is allowed to waste for hours. And with gas in the house it is the only way out of the difficulty. But with electric light, where no matches or getting on chairs is necessary, all that is wanted to be done to light up is to simply turn on a switch (a switch was shown and its action explained). This switch can be arranged near the door or in any convenient place easy to reach in the dark. The switching is done in the room, and, when finished, the light is turned off again by the same process. And not alone is the saving in expense enormous, but the great question of health comes into account. Wherever gas, oil, or candles are consumed a considerable amount of carbonic acid gas, a deadly poison, is produced, and I need not tell you how injurious its fumes are to everybody. They not only kill men in time, but silver is tarnished by them, and the ceilings, draperies, and papers are in time made unsightly. To give you an instance as to the health side of the question Mr. Preece, the well-known Post Office electrician, tells us that the electric light which has been introduced into the Savings Bank Department of the General Post Office, has decreased the hours of absence of the staff through sickness at the rate of two hours per head per annum. In other words, this means a saving to the Post Office of £680 per annum. Now the production of their electric light costs them £700 per annum all told. By putting in the electric light, therefore, the working of their staff was increased as by the addition of 200 hands, and, practically, their light only costs them £20 per annum through the decrease in their sick-list. This is an actual fact, on the authority of Mr. Preece, and there is no getting over facts. In schools, churches, public halls, and such places where many people congregate, the health question is most important, and to give you an instance of how it is unnoticed I went into a church last winter and was surprised to find the gas burning during the day, although the electric light was connected up. On enquiring the reason, I was told it was done to warm the church. Gas is all very well for warming when the poisonous fumes are carried away up the chimney, but when this is not done they are most injurious to the people inhaling them. The authorities are always anxious to promote sanitary matters in the way of drainage, pure water, and removing the refuse from the dustbins, but the sooner they turn their attention to the way people are deprived of good health by inhaling carbonic acid gas in our homes and crowded halls the better. As I mentioned before, our rooms are greatly damaged by gas lighting. In a large London restaurant where electric light is now laid on, I was told that the saving per annum through not having to redecorate the ceilings, and the saving of labour for cleaning the by-gas-tarnished silver, was simply enormous. It is just the same in a smaller way in our homes, and by adopting the electric light we are removing that which means ruination to our goods and chattels, and especially pictures. We introduce cleanliness, we add to our comfort, and, therefore, to our cheerfulness, and there is a total absence of all poisonous vapours. Mr. Hare, the well-known actor, has said that through adopting electric light he finds that life is made worth living, and I think you will agree from what I have said that he is not far wrong in his statement. I have endeavoured to point out to you, therefore, that electric light is a source of increased health and a saving to our purses by its cheapness and cleanliness. But there is another great item in its favour—namely, the absolute safety against fire that its use affords us. You may have read in the newspapers of fires caused by electricity. Perhaps, but very few in England. They mostly happened in America, where up to a recent date no laws were laid down regarding the use of the electric current. Here, however, we have a County Council to look after us, who, although sometimes over-anxious for the safety and welfare of the public, have certainly forwarded the absolute safety of electric lighting. In America the cables are put up in a careless fashion, and the quality of the insulation is far below the standard and would not be allowed in England. (Here a specimen of English-made cable was shown, and the method of insulating it explained.) The insulation should therefore be such that anybody can catch hold of the cables and yet not feel the slightest shock. In America these cables run overhead, and the insulation is often seen hanging down in rags. Naturally, the copper gets exposed, and anybody touching it is very likely to get a shock. In London our cables are now chiefly run underground in iron pipes 3ft. or 4ft. below the road, and are perfectly inaccessible to anybody but the company's inspectors. Fitting up the electric light to houses is now done to such a perfection—I am, of course, speaking of work done by well-known and reliable firms—that all risk of fire is abolished, and fire insurance offices are now giving a reduction in their prices where electric light is used. (Here the lecturer made a short digression on the subject of electric plumbers, and warned his hearers of the consequences of cheap and nasty wiring work.) The only chance of fire occurring through electricity is by reason of a wire overheating, but this is rendered impossible by using safety fuses. (The construction and action of a fuse and cut-out was here explained.) Thus we can protect not only a lamp, but a whole room, a floor, or the whole house. In case of fire through any other cause the fuse would melt in the same way, and all current would be cut off from the house automatically, which with gas is impossible. In a similar way whole streets can be protected, and finally the whole station. You see, therefore, that the electric light is absolutely safe against fire. The next great item in its favour is the easy means it affords us for decorating our homes practically, artistically, and effectively. Mrs. J. E. H. Gordon, wife of the well-known electrical engineer, has written a charming book called "Decorative Electricity," in which she suggests several ways of using the electric light as a means of not only illuminating, but decorating our homes. All rooms are taken into account, and such charming effects are described that I am sure all ladies will vote unanimously for its introduction into their homes without further delay. The candle-power of the lamp can be split up and so arranged that every part of the room is lit up instead of having one big cluster of lamps in the centre of the room. Cosy nooks and corners are well thought out, with a lamp ready to hand and in the very place where it is wanted. (The lecturer here described some of the decorative effects produced in Mrs. Gordon's house.) I have now endeavoured to put before your notice the many ways we can be benefited by the adoption of the electric light. Many people are prejudiced against it because they hear such dreadful accounts. These are exaggerated, to the detriment of the new rival illuminant. To give an instance. A new central station was opened in the vicinity of a milkshop. The proprietor objected to it on the ground that a leak in the mains had turned his milk sour. A butcher made the same complaint in another case, urging that the current escaped and spoilt his meat. The utter absurdity of these statements are apparent. If there is a leak in the system it returns to earth, where it practically came from, and you cannot feel a shock unless you connect both positive and negative poles through the body. You would not notice personally the leak in your house, but the supply company would at once by their instruments, and set to work to remedy it. It can be detected almost to a yard.

I think that a general summing up of the advantages gained by using the electric light will take the following form, which I want you to take home with you for severe reflection. We are introducing a cheaper illuminant, whose properties rather tend to purify than poison the air; we are removing from our midst the source of destruction to our ceilings, walls, pictures, and silver; we are encouraging cleanliness, which is next to godliness; we are furnishing our homes with a light that is excellently adapted for artistic and effective illumination; and we are ensuring our homes against risk of fire.

Discussion.

The **Chairman** said that if anyone had any questions to ask, Mr. Metzger would be happy to answer them.

Mr. Elliott asked as to the uncertainty of the light, had that been got over? Theatres, for instance, were compelled to keep gas burning as well as electric light to avoid accident or confusion in the event of the latter going out. Then as to the bad effect of arc lights on the eyesight. Could that be overcome? He knew they were all very anxious indeed to have a better and cheaper illuminant than they then had. He should like to see the electric light in Hendon. It might be the means of bringing the price of gas down, or they might leave their old friend altogether if they could get electric light as cheaply.

Mr. Turner asked as to the cost of wiring a house?

Mr. Metzger, in reply, explained that the reason why arc lights must be placed a good height above the ground was in order that they might not affect the eyesight by the intensity of their light. If people used arc lamps in shops they must not be surprised if their eyesight was affected. Incandescent lamps being of low candle-power, never higher than 200, and averaging eight, did not affect the eyes. As to the lighting of theatres, he did not know whether Mr. Elliott was referring to the past or present illumination of these buildings. Nowadays, the lighting was almost entirely done from electric supply companies' mains. Those theatres which employed their own plant to produce the current had to ensure themselves against all lights going out in the building, and so used gas as well. At Doyly Carte's new theatre, for instance, there was a brand-new plant, but they dare not rely on it, and so had the mains of a supply company taken in and ready to be switched on at any moment. The cost of wiring a house depended upon the fittings used, and how the rooms were situated. Roughly speaking, under favourable circumstances it would cost about £1 per lamp, including ordinary fittings. (A Speaker wanted to know if he could not give it per yard.) That was very difficult, because corners made a great difference in that case. It was not usual to charge by the yard. The ordinary way was for a wiring contractor to come and look over the house, and quote a price, which might range from 15s. or 20s. per lamp upwards. (A Voice: What is the cost of maintenance? Another Voice: What about the breakage of lamps?) The patents for these lamps, holding up an Edison-Swan, had not expired, but they would do so in the course of the next year or two. Last year they had to pay 5s. each for them. This year they were sold at 3s. 9d. He had reason to believe, however, that when the Edison-Swan patents ran out people would come forward who would be ready to supply that class of lamp for 10d. each. Not only would the lamps be cheaper, but a guarantee would be given for them to run a certain number of hours. With the Edison-Swan lamps, users had to take their chance—they might burn a thousand hours or half an hour. He had tried them himself, and had known one burn several thousand hours, while another lasted only a minute. (A Voice: But they are intended for a thousand.) Yes! (Another Voice: Do you ever test the lamps?) Of course, and if the Edison-Swan Company sent him one which would not burn, he would return it and obtain another in exchange. In answer to further questions, he explained that it was impossible to test these lamps for a number of hours consecutively, because the result would simply be to shorten their life, or perhaps break them, if the test was very prolonged.

Mr. Warburton, chairman of the Local Board, proposed a vote of thanks to Mr. Metzger for his very interesting lecture. He was sure the audience would be glad to hear from the lecturer whether it would be possible to introduce electric lighting into a scattered district like Hendon, with a reasonable prospect of its proving a pecuniary success.

In reply, **Mr. Metzger** said the alternate-current system was the best for scattered districts. Hendon district was somewhat longer than it was broad—in fact, it was an oblong. Having roughly sketched a plan on the blackboard, he said that he would suggest that the generating station should be placed near the railway for many reasons. First, because coal could be brought to it cheaply, and secondly, because they would not be liable to be indicted by neighbours as a nuisance on account of vibration. The current would be generated at the moderate pressure of 1,000 volts. (Here Mr. Metzger explained the relation of current to pressure, and the units by which they were denoted; alluding also to the difference between high and low pressure). Two mains would be brought from the station into the centre of the town—say, the Public Hall. Here the 1,000-volt pressure would be converted into the low pressure of 100 volts, electric light companies not being allowed to take 1,000 volts into a house farther than the cellar, because that pressure was thought to be dangerous. The Public Hall would be a sub- or transformer station, and from it mains would be laid under the streets to carry 100 volts pressure. The great advantage of this system, as compared with the low-pressure, was that they could work more economically, and avoid the drop in pressure which occurred with the latter. It was the same as with gas, where the pressure was lowest in houses farthest away from the works. As to the finance question, it was a difficult matter to say what would be the result of adopting electric lighting. If over 3,000 lights were taken up they would work at a profit, but at least this number must be running to make it pay. In a place like Hendon there would be churches, public halls, and schools which would be likely to take the light; and as there were many wealthy people in the place who would be sure to have it as well, he felt quite certain that 3,000 lights would soon be summed up. (A Voice: Of what candle-power?) They would be of 8 c.p. Of course, if any gentleman liked to put a 32-c.p. lamp up in his house, that would be reckoned as four of the 8-c.p. lamps, and so on with the higher power lights. In answer to a question from **Mr. Elliott**, as to what would be the average cost per mile of the mains, Mr. Metzger said that depended upon the pressure that was put on the cable. He proceeded to explain that in the first instance larger cables than would probably be required for the number of lamps at first taken up would have to be put down, in order that further demands for light might be met without having to take up these mains and lay down larger ones. On the high-pressure system the cable need not be nearly so large as on a low-pressure one. (Here he showed a specimen of a 2,000-light cable, and remarked that it would not take up much room in their streets.) Between the station and the Public Hall the cable would be small, because the pressure was high; after that the cables would be slightly increased in size because the pressure was low. (A Voice: Why has that lamp gone out?—alluding to an incandescent lamp over the speaker's head.) Perhaps because the filament—the thing which gave the light—had broken. Or, perhaps, from one cause or another, contact at the top of the lamp was broken by contraction or expansion of the parts. If that was so, all that was wanted to make the lamp burn again was to screw it tighter into its socket. In reply to a question from the **Chairman** as to the size of the 100-volt distributing cables, Mr. Metzger said that this depended upon the number of lights supplied. Electric mains were to a certain extent analogous to water mains. If the latter had to convey water at a very high pressure they were made of small internal diameter, and of stronger material than low-pressure ones. With electric mains for high-pressure work the copper was of small section, but the insulation was of a high class. The extra cost of the insulation, however, would not be so great as the extra amount of copper that would be required were the mains on a low-pressure system. This was the way they gained by using high pressure.

Mr. Turner having seconded the vote of thanks to Mr. Metzger, the latter gentleman briefly replied, and incidentally mentioned that the weight of the accumulators required to supply current for the lamps in the hall was five tons, a statement which caused considerable amusement. He hoped that the next time he had the pleasure of visiting Hendon they would have the electric light upon a very much larger scale.

Before the meeting separated many of those present examined the fittings, lamps, cut-outs, and cables placed on the platform, the details of each being explained by Mr. Metzger.

INSTITUTION OF ELECTRICAL ENGINEERS.

DISCUSSION ON THE DESCRIPTION OF THE STANDARD VOLT AND AMPERE METER USED AT THE FERRY WORKS, THAMES DITTON.

By CAPTAIN H. R. SANKEY, MEMBER, AND F. V. ANDERSEN, ASSOCIATE. *Authorised abstract.*

(Concluded from page 520.)

Captain Sankey further described the resistance A, used as an intermediary between the standard ohm and the rheostat B, and explained a diagram of it. He showed that there were two mercury contacts at the ends of each strip, and these were in parallel when the strips were in parallel. There were thus 10 contacts in parallel at each end, and calling the resistance of each contact *m*, and that of each strip *s*, the resistance in parallel will be $\frac{s}{5}+\frac{2m}{10}$. When the strips are in series there are five mercury contacts in series, and the resistance is $5s + 5m$. The parallel is therefore $\frac{1}{25}$th of the series resistance, the mercury contacts being eliminated. Recent tests of the resistance, A, when in series, gave 0·72678, and $\frac{1}{25}$th of this was 0·0290712. Direct measurement of the parallel resistance gave in two instances 0·029082 and 0·029075. He had tested a Siemens electro-dynamometer by the apparatus, and found its constant to be 28·50. The instrument was then sent to the makers to be recalibrated, the new constant being 28·41. The original constant was 28·67, and hence his determination was equal to the mean of the two given by Messrs. Siemens Bros. Two errors in Table I. of the paper were pointed out. In column 3, line 4, the number 0·417 should read 0·0104, and in column 4, line 3, the number 1·66 should be replaced by 1·57.

Prof. Ayrton exhibited several diagrams illustrating his previous remarks, and showed several of the latest types of d'Arsonval galvanometers. He expressed his high admiration of the most perfect arrangements provided by Messrs. Willans and Robinson for testing the efficiencies of their steam engines, and he hoped they would not misunderstand him when he made some suggestions as to how their electrical test apparatus might be modified with advantage. The improvements made in d'Arsonval galvanometers by using curved pole-pieces and freely-suspended coils he illustrated by the calibration curves of two instruments drawn to a very large scale. The deviation from proportionality in the case of the improved form was inappreciable, whilst that of the ordinary type was very pronounced. He also directed attention to the fact that it was not necessary to use a large square sheet of sectional paper for such calibrations, only a narrow diagonal strip cut from the roll at an angle of 45deg. being required. The arrangement of platinoid sheet and d'Arsonval galvanometer used as a standard ampere-meter at the Central Institution, and also the hexagonal multiple scale fitted up at the Acme Works, were illustrated by diagrams, and the secular variation of sensibility of d'Arsonvals were shown by means of tables. Referring to recent forms of instruments he showed two new d'Arsonvals, both provided with adjustable magnetic shunts. One of these had been made by Mr. Pitkin, and the other by Messrs. Nalder Bros. and Co., the coil of the former instrument being wound with "manganin" wire, and that of the latter with platinoid. Both instruments had curved poles and freely-suspended coils. Carpentier's long-range d'Arsonval, an instrument deflecting through 180deg., was exhibited, together with a shunt, by means of which the sensibility could be greatly varied. Speaking of the shape which should be given to the coils of d'Arsonval galvanometers, he called attention to a note on the subject presented to the Physical Society in March, 1890, by Mr. T. Mather, and he exhibited an instrument embodying the improvements there suggested. This galvanometer had a long narrow coil, and no iron core, and, for its winding, was the most sensitive d'Arsonval he (Prof. Ayrton) had yet tested. On the subject of platinoid-sheet rheostats, he said that instead of using a large surface, 6ft. by 3ft. 2in., as Captain Sankey and Mr. Andersen did, it would be better to have two sheets—one for currents, say, from five to 110 amperes, and the other from 50 to 1,100. If the narrow-coil low-resistance instrument mentioned above be used, the former platinoid sheet would require to be about 5in. square and the latter 15in. square; with these the same range of current could be measured as with Captain Sankey's large rheostat, and no temperature corrections whatever need be made to obtain an accuracy of ¼ per cent. Further, the expenditure of power when measuring 1,100 amperes would only be 40 watts, whereas the strip described in the paper absorbed about 1,300 watts when measuring the same current. He was glad to see the close agreement in Captain Sankey's measurements of the rheostat

A in parallel and series, and wished to know why it was considered necessary to measure it in series at all, seeing that it could be measured so accurately in parallel, the condition in which it was used. The mercury contacts, although nominally eliminated, were nevertheless a source of uncertainty, and where the value of a resistance was of such vital importance their use should be avoided. Some of his students had recently tested such contacts and found them to vary greatly, according to their condition; in one case the resistance fell from ·00266 to 0·00058 on being cleaned and reamalgamated. For calibrating the ampere-meter, he recommended the use of a known current measured, say, by a Thomson balance; for in this way all troublesome and uncertain measurements of small resistances were avoided.

Mr. Crompton said he wished to call attention to a few points which appeared to have been misunderstood. In the first place, some persons said the paper under discussion was unworthy of the Institution; with this he entirely disagreed, and thought the idea arose from misconception. He himself considered the paper a capital one to commence the session with, and particularly interesting to rising electrical engineers. The details of practical testing apparatus were always valuable, and little dodges, of great use to others, always accompanied papers such as the one before them. Again, English electrical engineers had established what was known as the English system of arranging central stations—viz., the combination of high-speed engines with direct-driven dynamos. Efficiency tests of this system showed that it gave better results than any other system. The Institution of Civil Engineers had acknowledged the completeness and accuracy of the "engine efficiency" tests of Messrs. Willans and Robinson, and he (Mr. Crompton) thought the electrical tests made, as described in the paper, were quite accurate enough for present requirements. Speaking as one who had paid considerable attention to accurate electrical measurement, he doubted whether resistances could be measured to one part in 10,000, as stated in the draft Order in Council prepared by the Board of Trade. He had made many tests and had taken the greatest pains to obtain accuracy, but he found that it was not possible to get resistance-boxes sufficiently well adjusted. Surface leakage difficulties were also very great, particularly in a London atmosphere. In their measurements at Chelmsford they preferred the zero method, and used d'Arsonval galvanometers, Clark's cells, and potentiometers. The chief reason for the preference was, that it was so easy to repeat a measurement and errors were so readily detected. He enquired why Prof. Ayrton had not used electromagnets, instead of permanent ones in d'Arsonval galvanometers, in some such way as Mr. Kapp and himself had done in ammeters and voltmeters some years ago. At present he was engaged on an electromagnet instrument which he hoped would be a great improvement on any yet made.

Mr. Swinburne described the system of measurement explained in the paper as a calibrating system. In most station work it was usual to employ ampere-meters and voltmeters, and he thought this would continue. Such instruments were, however, of two classes, the accuracies of which were very different. It would not be satisfactory to use a voltmeter intended for house work, and costing three or four guineas, in a station where an accuracy of a fraction of a per cent. was required. A letter-balance was a very good thing for its purpose, but it would be totally unfit for chemical weighings. Captain Sankey and Mr. Andersen had, he understood, put up the arrangement described, because they could not put confidence in other people's calibrations—neither could he himself; but a good instrument calibrated by the user would, he believed, be more satisfactory than the arrangement now before the meeting. He objected to "spot watching" in central stations, and thought the d'Arsonval galvanometer would not stay. A voltmeter might be accurately calibrated just as well as a d'Arsonval galvanometer. Most of the tests depended on standard cells, and considerable difference of opinion existed with regard to their reliability. If made in the same way from the same materials, good agreement could be obtained between different cells, but this did not say they were right. Other persons were sceptical about the reliability of double-wound series resistances, and to examine this point his assistant (Mr. Bourne) made a coil of two insulated wires wound side by side. The insulation resistance was found to be over 600 megohms, and the insulation did not break down until the pressure between them amounted to 950 volts. This, he considered, proved that they were quite reliable. On the subject of platinoid, he enquired whether its properties were permanent, and said that he could find no tungsten in it, and thought it was merely German silver with a large proportion of nickel. Speaking of resistance measurements, he said that for small values the fall of potential method was the most suitable, and by it a single bar of an armature could be easily tested. With reference to the use of electromagnets mentioned by Mr. Crompton, he said that Mr. Boys had tried them, and found little or no advantage. Thomson galvanometers were much more sensitive than d'Arsonvals, and the only drawback was their being affected by external fields; but even this was not very important in null methods. In conclusion, he rather objected to a statement by Prof. Ayrton about the arrangement described by the authors being accurate enough for workshop purposes, and he pointed out that the most accurate measurements made, those of weight and length, were made in workshops, the former in commercial analysis, and the other by Whitworth measuring machines.

Mr. S. Evershed was surprised that more attention had not been paid to inaccuracies inherent to the instruments, for in addition to the variation of resistance with temperature, springs, torsion wires, magnets, etc., had temperature coefficients which ought to be investigated. Good magnets with fairly closed circuits were very permanent when left untouched and he had used a tangent galvanometer with permanent magnet control for several years as a standard ampere-meter, and the change had been very small. The magnets of one d'Arsonval galvanometer he tested had a temperature coefficient of about 0·01 per cent. This was considerably lower than those usually found for magnets used in magnetic observations (0·02 to 0·03 per cent.), but several samples of Jowitt's steel tested by Mr. Vignoles gave about 0·01 per cent. per degree C. He therefore thought the ordinary coefficient was between 0·01 per cent. and 0·02 per cent. Speaking of the position of the point of attachment of the potential wires on the platinoid strips, he said they should be placed at some distance from the ends, so that the flow of current in the strip may be properly distributed. The new alloy "manganin" was, he believed, first tested in England by himself. Its temperature coefficient when received from the maker was very small, and was negative; but on having a wire drawn down to a smaller size, its coefficient became positive. On enquiry, he learned that to prevent this occurring, a special method of drawing had to be adopted. Another specimen had a temperature coefficient about 0·01 per cent. per deg. C. between 0deg. and about 160deg. C., but on keeping it heated to 160deg. its resistance fell considerably, and its specific resistance was permanently altered; its temperature coefficient was, however, about the same. From this he concluded, that if permanency was required, it should never be heated above 100deg. C. There was one form of d'Arsonval galvanometer which, although it had not been referred to, was worthy of attention—viz., the Weston voltmeter. He had recently tested one, and found it remarkably good and very accurate.

Mr. A. P. Trotter wished to compliment the authors on the successful system they had carried out. He said it should be borne in mind that there were three classes of measurement carried out respectively in laboratories, workshops, and instrument-making factories. When the Society of Telegraph-Engineers, was first founded, resistances were measured in miles of telegraph wire, and E.M.F.'s in Daniell cells. Subsequently, when the name was changed to Society of Telegraph-Engineers and Electricians, laboratory methods were employed, but now it was necessary to measure still more scientifically, and to an accuracy worthy of the Institution of Electrical Engineers. He considered the method adopted at Messrs. Willans and Robinson's a laboratory one, and thought the d'Arsonval galvanometer had not come to stay, for "spot watching" was not acceptable to engineers. Quartz fibres had also revolutionised Thomson instruments, and they were now much more sensitive and reliable. At present he did not see that workshop electrical measurements need be made to an accuracy of less than one in a thousand.

Mr. Willans said the need for such an arrangement as that fitted up by Captain Sankey and Mr. Andersen arose from the fact that dynamo makers had confidence in no measuring instruments except their own. They (Messrs. Willans and Robinson) formerly used Siemens instruments, but the zero adjustment was troublesome, and only one person at a time could take the readings. With a spot of light two or more may take the reading, and this gave confidence to the parties interested. The average value of the quantities were those required, and Captain Sankey's method of taking the mean deflection and then calibrating it was, he thought, preferable to Mr. Crompton's zero method, or that of Prof. Ayrton, who relied on the spot always being in a definite place. The general result of the more accurate testing arrangements was to slightly lower the efficiencies. This, he said, was what might have been expected, for with imperfect instruments one was likely to take the highest of the several values obtained. Their experience was that most commercial instruments were unreliable when used in workshops near masses of iron, etc., hence the d'Arsonval form was adopted.

Captain Sankey, in reply to Prof. Ayrton, said that the latter depended on the accuracy of his cells, whilst they did not; hence the devices for proportionality were in their case unnecessary. By using a large rheostat they were able to employ a galvanometer of fairly high resistance with sufficient accuracy, and then their ampere-meter galvanometer and their voltmeter galvanometer were interchangeable. The method of calibrating by using a known current was hardly possible in a workshop, for the copper deposit method was not convenient, and if another standard instrument be employed they would be depending on other people's calibrations. To avoid this, the method of checking and standardising described in the paper was devised. To Mr. Evershed he pointed out that as the value of the mean deflection was determined immediately after every important test, the additional corrections he had referred to were eliminated. In designing the rheostats, they had taken care to put their potential wires at points where the flow was uniform.

Mr. Andersen said that in calibrating the mean deflection, only the standard ohm and the standard cell were relied on. Ohms could be made so as to be very near the Board of Trade requirement of one part in 10,000. As regards cells, Mr. Swinburne seemed to be under too much apprehension about them. He himself knew from experience that they could be made up to agree very closely with the standard value, when once one had got the "knack" of doing it. He was glad to know that "spot watching" had a good chance of being largely used by engineers, for a good spot was far superior to any pointer. Referring to the design of d'Arsonval galvanometers, he said some of the points mentioned by Prof. Ayrton were good, but he did not agree with the system of winding them with platinoid. An instrument so wound was necessarily about 25 times less sensitive than one wound with copper. Curved pole-pieces and freely-suspended coils were good—the latter he himself had used several years ago. Magnetic shunts he thought unsuitable for workshop use. A resistance-box was better, for one could trust a person to use the proper plugs

The six scales on the roller he considered unnecessary, for only one scale was required and five other sets of figures.

The **Chairman** (Mr. A. Siemens) agreed with Mr. Trotter as to the great advance made in electrical measurement since the formation of the society. The paper now before the Institution was a proof that electrical engineering had now become a science, and he doubted whether any other profession could show such a record of progress made in so short a time.

LONDON COUNTY COUNCIL.

At the last meeting of the Council the following report was submitted by the Finance Committee relating to the proposed

Loan to the Vestry of St. Pancras:

We have acted on the permission of the Council to consider further the application from the Vestry of St. Pancras for sanction to borrow and for the loan of £60,000 for electric lighting works, to be repayable in 42 years. We reported on the cost (£62,999. 7s. 5d.) of the proposed works on the 17th November, and recommend a loan of £56,300, repayable as to certain parts in varying periods of five, eight, 15, and 30 years, such varying periods being fixed on the advice of the engineer with reference to the probable life of the work on which the expenditure would be made. Consequent on the discussion which took place at the Council on the 17th inst., we have seen a deputation from the Vestry, who have pointed out to us that the works as a whole will make up a permanent going concern, and must, whenever necessary, be renewed from time to time out of the Vestry funds, so as to be kept always in good working order. We pointed out to the deputation that the Council was, under its present powers, precluded from granting loans for works for a longer period than 30 years, except for street improvements and bridges; but while admitting this, they urged, in view of applications likely to be made by other parishes for loans to carry out similar works, that the Council should obtain statutory authority to grant loans spread over a period not exceeding 60 years. Under these circumstances, we consider that it will be better for the Council to authorise the Vestry to borrow elsewhere than from the Council £60,000, leaving open the question of the Council's advancing this sum, if parliamentary authority is obtained for a longer period than 30 years. We therefore recommend:

> (*a*) That the sanction of the Council be given under seal to the borrowing by the Vestry of St. Pancras of the sum of £60,000, towards defraying the cost of certain electric lighting works, at a rate of interest not exceeding £4 per cent. per annum, and the principal being repaid by equal annual instalments within a period of 42 years from the date of the loan.
>
> (*b*) That the Council do apply to Parliament for power to make advances for electric lighting purposes to vestries and other rating authorities within the county of London, for periods not exceeding 60 years, and that it be referred to the Parliamentary Committee to take steps to obtain the necessary statutory authority for that purpose.

Mr. Campbell said he would be the last to throw any obstruction in the way of so enterprising a parish as St. Pancras. The duty of the Council with regard to these loans was to see that posterity was not unfairly burdened, and that the present generation were not allowed to play ducks and drakes with the money of posterity. The St. Pancras Vestry deserved the greatest credit for getting the provisional order to carry out their own electric lighting. In Kensington they did the same, but the difficulties and dangers seemed to them more than they were inclined to go in for. Electric lighting, he considered, could best be provided by private companies if they were not allowed too much tether, as the gas and water companies had been. They ought to recollect that a vestry had the authority to mortgage the rates. Electric lighting was comparatively in its infancy, and in the next 10 or 15 years heaven knew what the lighting of London would be. It probably would be electricity, he thought it would; still it was not yet so well established as gas was 20 or 30 years ago. The law was exceedingly defective with regard to these loans. He hoped the efforts of St. Pancras would be successful, and that other parishes would be induced to do the same thing; but he thought it fair, honest, and right that the Council should discuss the matter fully, and that they should know what they were about before they put those burdens on the ratepayers of another generation. He moved that the report be referred back to the committee for further consideration.

Mr. John Lloyd seconded the amendment, as he objected to the Council departing from the principle which they had laid down as guiding them in making loans. In this case they would have their capital in property which would be wearing out.

Mr. Osborn supported Mr. Campbell's proposition. It seemed to him an extraordinary thing that they should take out of the rates sums of money to put up plant of very short life, and spread their repayment over 42 years. Hitherto they had taken great care in granting money to local authorities to see that there was ample security for the money. In the case now before them they had none whatever. The parish of St. Pancras was starting with considerable doubt as to the success of the project, and they ought to remember the advances in electric lighting which would involve alterations. In his opinion they ought not to go beyond 12 years, and certainly in no case ought they to go beyond 15.

Mr. Howell Williams said it was quite true that some of these works would not last 42 years, but the installation would last that time, and every possible cost of maintenance would be met out of profits.

Mr. Ford thought that in making this loan they would be advancing money certainly far in excess of the life of the security.

Mr. Clarke said he looked with alarm on the Council authorising loans for such a period on such perishable articles.

Mr. Harben said they were there to protect the rates, and not to develop these companies, and if they could by any means with safety to the rates give public authorities an equal chance they ought to do so.

Mr. Westacott reminded the Council that they were not agreeing to lend the St. Pancras Vestry the money; they were only authorising them to borrow it for a period not exceeding 42 years.

Mr. Campbell: On the security of the rates.

Mr. Westacott asked whether it was not better for the parish, its ratepayers, and consumers that the Vestry should undertake this work when they could borrow at a low rate of interest rather than that speculators should come in and by-and-by induce the Council to buy the works at a large price. He hoped the Council would encourage the Vestry of St. Pancras.

Lord Lingen, the chairman of the Finance Committee, said it was seldom that he appeared before the Council to advocate a long in preference to a short period of repayment. His own opinion was most strongly, as a rule, in favour of short periods. That doctrine had not always been readily welcomed there, and he hoped after the feeling which had been shown on that proposal the doctrine would receive more favour in future. They had told the applicants that with their present powers they could not lend to them for more than 30 years. It was impossible for the Council to shut its eyes to the fact that the example which St. Pancras set in that matter was an extremely important one. Parliament had expressed an opinion on the whole favourable—certainly not unfavourable—to the idea that the municipalities should undertake for themselves, and not leave to comparatively independent companies, such undertakings as involved the breaking up of the streets. That, on the whole, he thought was a sound policy. Supposing St. Pancras did not go into the open market to borrow this money, the only alternative was that they must go to Parliament, and he himself rather leaned to the idea that they should go to Parliament, because, if they considered the magnitude of London and the enormous importance of the lighting of it as to its being done in the most efficient and economical manner, he thought it really was a question of parliamentary magnitude. The Council, therefore, by adopting the recommendations of the committee, did not commit themselves to any very dangerous precedent.

The amendment was rejected, and the recommendation of the committee agreed to.

Overhead Wires.

The Highways Committee reported concerning overhead wires that by Section 5 of the London Overhead Wires Act, 1891, the Council is empowered to make and vary by-laws with respect to (*a*) the identification of overhead wires by registration or otherwise; (*b*) the regulation of wires; (*c*) the strength of the materials to be employed in placing, maintaining, and supporting wires; and (*d*) the removal of wires erected or placed otherwise than in accordance with such by-laws and of disused wires; and the Council may by such by-laws fix and determine the penalties to be imposed on the company or person failing to comply with any of the provisions of the Act, and continuing penalties in the event of any such offence being continued after conviction thereof. These by-laws are, however, to be of no effect until approved by the Board of Trade, which department is to prescribe to whom and in what manner notices of the intended by-laws shall be given; and it is further provided that before such by-laws are proposed to the Board for confirmation notice thereof, with copies of the intended by-laws, is to be given to the Postmaster-General. The general administration of the Act, and the enforcement of the by-laws when made by the Council and confirmed by the Board of Trade, devolve upon the local authorities—*i.e.*, within the City of London, the Commissioners of Sewers, and outside the City the vestries and district boards, except on the Victoria-embankment and the bridges, which are vested in the Council. We have prepared a series of by-laws (a copy of which has been sent to each member of the Council), and the Board of Trade has prescribed to whom and in what manner the notices of the intended by-laws shall be given. It is probable that some exception may be taken by companies and others interested to some of the provisions contained in these by-laws, and we are of opinion that we should have instructions to consider any suggested alterations and to represent the the Council before the Board of Trade. We recommend:

> That the draft by-laws under the London Overhead Wires 1891, be approved, and that it be referred to the Highways Committee to issue notices and to take all other necessary measures to obtain the confirmation of the by-laws, including, should the committee consider it advisable, the employment of counsel to support the by-laws before the Board of Trade.

The consideration of this matter was postponed.

A Dynamo to be Purchased.

With regard to meter testing, the report said: We have to report that it has been found impracticable to test with the current supplied by the Metropolitan Electric Supply Company, meters, of the pattern approved by the Board of Trade, sent in by the House-to-House Electric Light Supply Company, on account of the difference in the number of alternations used by the two companies; and that in order to overcome the difficulty it will be necessary to obtain an alternating-current machine, driven by a motor, the cost of which will be £373. 10s., and also a switchboard with the requisite connections, at a cost of about £55. It is expected that by means of this apparatus, in conjunction with that already obtained and at the station, electric-light meters of any kind at present known can be tested; and we recommend:

> That, subject to an estimate being submitted to the Council by the Finance Committee as required by the statute, the Highways Committee be authorised to obtain, at a cost not exceeding £450, the additional apparatus above referred to, for use at the electric meter testing station.

This was agreed to.

It was also reported that a number of notices relating to the laying of cables had been received, and the committee recommended their approval.

OVERHEAD WIRES.

BY-LAWS OF THE LONDON COUNTY COUNCIL.

Herewith we give a copy of the by-laws prepared by the Highways Committee of the London County Council under the London Overhead Wires Act, 1891, which were submitted to the Council at its meeting on Tuesday last. As will be seen from our report of the meeting given in another column, consideration of the matter was postponed.

In these by-laws the expression "company" includes person. The expression "wire" includes any wire conductor or cable, any part of which is placed, or shall hereafter be placed, over any street or any part of any street, and also any wire conductor or cable placed, or intended to be placed, on or over any building or land, and situate at any point within a distance of 50ft. from any street, but shall not include any such wire conductor or cable which is placed, or may be placed, wholly upon or over any railway or any land belonging to a railway company and used as a railway station, siding, or yard, or any part of any such wire conductor or cable being upon or over any railway or such land. The expression "cable" includes any covered or insulated wire when the thickness of the covering or insulation exceeds the diameter of the wire, and any number of insulated wires combined in one cable, whether stranded or separate.

1. Within three months after the approval of these by-laws by the Board of Trade, every company owning or using or claiming power to use any wire or wires existing at the date of such approval shall, for the purpose of registration and identification, deliver to the Council and to the local authority in whose district the same are situate (upon a form to be obtained from the Council) full particulars of all such wires, the particulars to be accompanied by a plan showing the routes of the wires, and to give full information as to—material of wires and supports; gauge of wires; mode of support, giving dimensions of poles, stays, and other supports and attachments; position of each support; date of erection and of last renewal (if any).

2. Any company proposing, after the approval of these by-laws, to erect any wire, or any support or attachment thereto, shall, not less than 14 days before the work is commenced, deliver to the Council and to the local authority in whose district the same are situate (upon a form to be obtained from the Council) full particulars thereof, the particulars to be accompanied by a plan showing the route of the wire and to give full information as to material of wire and supports; gauge of wire; mode of support, giving dimensions of the poles, stays, and other supports and attachments; position of each support. And no wire support or attachment shall be erected otherwise than in accordance with such particulars and information.

3. No post or support for any wire shall be placed or erected in any street without the previous consent in writing of the local authority.

4. No wire shall at any point be at a less height above the ground than 20ft., or where it crosses a street 35ft., or at a less height above any building than 7ft., except where brought into any building for use in such building, or when attached to chimneys or other parts of buildings in accordance with these by-laws.

5. Every wire shall be supported at intervals not exceeding 115 yards, unless permission in writing be obtained from the Council and the local authority for a longer span, but in no case shall the distance between supports exceed 140 yards.

6. Where any wire crosses a street the angle between the wire and the direction of the street at the place of such crossing shall not be less than 60deg.

7. Every support for a wire shall be of durable material, and properly stayed against forces due to wind pressure, change of direction of the wires, and unequal length of span; and all wires, whether conductors or suspending wires, shall be securely attached to the supports, and shall be shackled off at each support.

8. The factor of safety for all conductors and suspending wires shall be at least five, and for all other parts of the structures at least ten, taking the maximum possible wind pressure at 50lb. per square foot. No addition need be made for a possible accumulation of snow.

9. Every support for a wire shall be marked to the satisfaction of the Council in such manner as to enable inspectors to know at once to what company it belongs. Every new support for a wire shall also have the date of erection marked thereon.

10. No support for a wire which carries more than 10 wires shall be used for the wires of more than one company, and no support carrying fewer than that number shall, without the previous consent in writing of the Council and the local authority, be used for the wires of more than one company.

11. No single support for a wire shall be used for more than 20 wires without the consent in writing of the Council and the local authority.

12. Cables (where used) shall be carried by independent suspending wires and attached to the same by efficient slings; no cable shall exceed 1in. outside diameter, and 1lb. per lineal yard in weight.

13. All iron or steel wires, and all iron or steel supports or attachments shall be galvanised

14. All poles supporting wires erected on buildings shall be carried on properly galvanised iron shoes and saddles, and efficiently stayed so that in the event of a pole breaking, it shall be impossible for it to fall into any street.

15. Every support for a wire if of metal shall be efficiently connected to earth, and if of non-conducting material, shall be protected by a lightning conductor, fastened to the support along its entire length, and projecting above it to a height of at least 6in., such lightning conductor being efficiently connected to earth.

16. Where a wire is attached to any wall, chimney, or similar erection, a suitable angle-plate or other suitable device of iron securely fixed shall be used.

17. Every wire, together with its supports and all structural parts belonging to or connected with it, shall be duly and efficiently supervised and maintained by the company to which it belongs.

18. No wire, support, or attachment shall or may be in such a condition that danger to the public using the streets may be apprehended therefrom, and the company to whom such wire, support, or attachment which is in such a condition belongs, shall be guilty of an offence against these by-laws.

19. No wire or support or attachment thereto shall remain erected for more than one month after it has ceased to be in use unless the company intend within a period not exceeding three months to take it again into use, and of such intention shall give notice to the Council and the local authority.

20. Every company shall give or secure access at all reasonable times for the purpose of the inspection and examination of any wire, support, or attachment, and other apparatus used in connection therewith, to the Council and the local authority, their officers, and servants.

21. Any company which shall erect or cause to be erected any wire, support, or attachment, otherwise than in accordance with, or shall fail to comply with, or shall act contrary to, any of the requirements of the foregoing by-laws, or shall deliver to the Council or the local authority pursuant to these by-laws any incorrect particulars or information, shall be deemed to have committed an offence against the same, and shall be liable for every offence to a penalty of £10, and in case of a continuing offence to a further penalty of 40s. for each day after conviction, provided, nevertheless, that the justices or court before whom any complaint may be made, or any proceedings may be taken in respect of any such offence, may, if they think fit, adjudge the payment as a penalty of any sum less than the full amount of the penalty imposed by this by-law.

22. Nothing in these by-laws shall extend to any wire placed by any person for his private use over land belonging to him or in his occupation which does not extend over any street, and is so constructed and placed that neither the wire nor any support thereof or attachment thereto would be liable to fall into any public street.

NEW COMPANIES REGISTERED.

International Electric Subway Company, Limited.—This Company has been registered, with a capital of £25,000, in £1 shares, to acquire, work, and develop any patents or patent rights of or in connection with underground conduits, whether electrical or otherwise, or electricity, electric machines, or apparatus for the generation or transmission of electricity.

Johannesburg Lighting Company, Limited.—Registered by Ashurst, Morris, Crisp, and Co., 17, Throgmorton-avenue, E.C., with a capital of £150,000 in £1 shares. Object: to manufacture and supply gas and electricity for lighting, warming, motive power, etc., in the town of Johannesburg and elsewhere, and generally to carry on the business of oil, tar, coke, and chemical manufacturers and merchants, miners and smelters, engineers, etc.; and, with a view to the foregoing objects, to carry into effect an agreement expressed to be made between the Johannesburg Gas Company, Limited, W. G. Soper, W. F. Lance, and A. Jones of the one part and this Company of the other part. The first subscribers are:

	Shares.
W. F. Lance, 7, Grotes-place, Blackheath	1
W. G. Soper, Bury-street, St. Mary-axe	1
A. Jones, 15A and 16A, Bury-street, E.C.	1
W. H. Adams, 168, Friern-road, East Dulwich	1
E. T. Botwright, 11, Oxford-road, Gunnersbury	1
W. B. Butler, 2A, Sixth-avenue, London, W.	1
W. G. Yeoman, 89, Brayard-road, Queen's-road, S.E.	1

There shall not be less than three nor more than seven Directors the first to be appointed by the signatories to the memorandum of association. Qualification, £250. Remuneration: Chairman, £200; ordinary Directors, £100 each per annum.

Patent Electromagnetic Clock Syndicate, Limited.—Registered by William Beck, 2, East India-avenue, E.C., with a capital of £25,000 in £1 shares. Object: to carry into effect two agreements, the first, made October 15th, between William Rutton May and another, of the one part, and A. Hoster, of the other part: the second, made November 25th, between W. R. May, of the one part, and V. Laroni, on behalf of this Company, of the other part, for the acquisition of certain patents relating to improvements in electrical timepieces, and generally to work and develop the same. There shall not be less than three or more than seven Directors; the first to be appointed by the signatories to the memorandum of association. Qualification not specified. Remuneration, £500, with an additional 5 per cent. on the amounts paid by the Company in dividends, the same to be divisible.

National Telegraph Works Company, Limited.—Registered by A. P. Honeyman, 9, Bennett's-hill, Birmingham, with a capital of £5,000, in 990 £5 ordinary shares and 50 £1 founders' shares. Object: to carry into effect an agreement expressed to be made between J. S. Lewis, of the one part, and this Company of the other part, and generally to carry on business as manufacturers, merchants of, and contractors for, pressed steel, iron, or other metal, and as electrical engineers, contractors, etc. There shall not be less than two nor more than six Directors. The first are J. S. Lewis and A. H. Church, both of Birmingham. Qualification, 50 ordinary shares, or one founder's share. Remuneration to be determined by the Company in general meeting.

New Motor Syndicate, Limited.—This Company has been registered, with a capital of £5,000, in £10 shares, to adopt an agreement, dated August 12, 1891, between Mr. T. C. Hersey of the one part, Mr. William Knight of the other part, and to carry on any business which may be acquired.

CITY NOTES.

City and South London Railway.—The receipts for the week ending November 29 were £806, as against £793 for the week ending November 22.

Eastern Telegraph Company.—The receipts for November were £60,053, as against £59,975 for the same period of 1890, an increase of £1,073.

Brazilian Submarine Telegraph Company.—A quarterly interim distribution of 3s. per share is announced by the Company, payable on the 21st inst.

Eastern Extension Telegraph Company.—The receipts for November amounted to £40,686, as against £44,742 in the corresponding period, showing a decrease of £4,056.

Shippey Bros., Limited.—We are informed that the entire block of shares in the above Company recently placed on the market has been purchased by Messrs. Gwynne and Co., engineers, of Essex-street, Victoria-embankment, E.C.

Pilsen Company.—We learn that the Pilsen Electric Company have secured an exclusive license from the proprietors of the C. & C. motor patents to manufacture and supply the well-known Curtis, Crocker, and Wheeler electric motors, electric pumps, blowers, etc., both for England and France, and that the Pilsen Electric Company, whose business has recently been removed from Stanhope-street to larger and more complete works, 80, Leather-lane and Baldwin's-gardens, Holborn, intend to vigorously push the Crocker-Wheeler systems throughout the United Kingdom.

PROVISIONAL PATENTS, 1891.

November 23.

20312. **Improvements in the form of electrical battery cells, boxes, or other vessels.** John Miles Moffat, 100, Victoria-street, Westminster, London.

20314. **Electrical thermometer.** James Gratton, 3, Peel-terrace, Peel-street, Nottingham.

20328. **Improvements in producing alternating currents differing in phase.** Rankin Kennedy, Carntyne Electric Works, Shettleston, Glasgow.

20356. **Improvements connected with electric arc lamps.** Webster Storr, 166, Fleet-street, London.

November 24.

20367. **Improvements in couplings for electric wires.** Alexander Shiels, 70, Wellington-street, Glasgow.

20389. **Magnetic microphone.** Edward Turner Whitelow, 70, Deansgate, Manchester.

20413. **Improved electrolytic apparatus, more particularly for manufacturing caustic soda and other products from salt, but also applicable to other purposes.** Godfrey Bamberg, 28, Southampton-buildings, London.

20416. **Improvements in apparatus for separating magnetic ore from sand.** Francis James Bell and Walter Bassett Basset, 28, Southampton-buildings, London.

November 25.

20485. **Improvements in automatic safety devices for electric circuits.** Frank Bryan, 11, Brackley-terrace, Chiswick, London. (Complete specification.)

20492. **Regulating electric currents.** Leslie B. Miller and Maurice W. Woods, 34, Gray's-inn-road, London.

20496. **Electrical switch.** Alfred Champion and James Moss, 112, Shardeloes-road, New Cross, London.

20506. **Improvements in microphone transmitters.** Sir Charles Stewart Forbes, Bart., 21, Finsbury-pavement, London.

20508. **Improvements in and relating to dynamo-electric machines.** Thomas Henry Williams, 70, Chancery-lane, London.

20530. **Improvements in and relating to ship telegraphs.** Albert Barthold Wilhelm Henry Cords, 46, Lincoln's-inn-fields, London.

November 26.

20542. **Improved incandescent lampholder and form or shape of incandescent lamps.** Thomas John Rickard, Beaconsfield Cottage, Sebastopol, Newport, Monmouthshire.

20545. **An improved system of telephonic exchange signalling.** Alfred Rosling Bennett and Robert McLean, 22, St. Albans-road, Harlesden, London.

20595. **Improvements in arc lamps.** Frederick Richard Boardman, 433, Strand, London.

20604. **Improvements in electric motors or generators.** Henry Harris Lake, 45, Southampton-buildings, London. (William Stanley, jun., and John Forest Kelly, United States.) (Complete specification.)

November 27.

20623. **Improvements in telephone transmitters.** William Maxwell, 34, Claybrook-road, Fulham, London.

20629. **Improvements in holders for incandescent electric lamps.** Charles Mark Dorman and Reginald Arthur Smith, 24, Brasenose-street, Manchester. (Complete specification.)

20678. **Improvements in electric burglar alarms.** Franz Pohl, jun., 18, Buckingham-street, London. (Complete specification.)

20689. **Improved cementitious and electric insulating compounds.** Murdoch Mackay, 166, Fleet-street, London.

20699. **A new or improved electric indicator.** Harold William Thatcher and Arthur Devereux, 22, Glasshouse-street, London.

November 28.

20718. **Magnetic electric boot and shoe (iron and steel) grindery.** Percival Pickney, 151, Somers-road, Southsea, Hants.

20748. **Treatment of and production of valuable products from sludge obtained by electrical treatment of sewage.** Frank Scudder, 46, Lincoln's-inn-fields, London.

20799. **Improvements relating to electric call systems and apparatus for use therein.** William Hamilton Blakeney, 45, Southampton-buildings, London.

SPECIFICATIONS PUBLISHED.

1890.

17863. **Electric lamps.** Hardt. 8d.
18555. **Electrical switches.** Pierce. 6d.
18557. **Electrical switches.** Pierce. 6d.
18558. **Electrical pendants, etc.** Pierce. 8d.
20102. **Dynamo-electric machines.** Baxendale. 6d.
20896. **Regulating electric currents.** Gay and Hammond. 11d.

1891.

40. **Electricity meters.** Hookham. 8d.
200. **Electric arc lamps.** Brianne. 8d.
271. **Electric arc lamps.** Schoenerstedt. 8d.
617. **Electric arc lamps.** Allison. (Ward.) 11d.
5043. **Arc lamps.** Money and Nash. 11d.
10239. **Railway electrical block systems.** Guiley. 8d.
12322. **Electrical welding.** Boult. (Bassle.) 8d.
16487. **Primary batteries.** Leigh. (Gardiner.) 6d.
16989. **Printing telegraphs.** Lake (Farmer.) 8d.
17003. **Secondary batteries.** Madden. 11d.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Brush Co.	—	3¼
— Pref.	—	2¼
India Rubber, Gutta Percha & Telegraph Co.	10	10½
House-to-House	5	5
Metropolitan Electric Supply	—	10¾
London Electric Supply	5	1¼
Swan United	3½	4¼
St. James'	—	8½
National Telephone	5	4½
Electric Construction	10	7
Westminster Electric	—	0¾
Liverpool Electric Supply	5	5¼
	3	2¼

NOTES.

Singapore.—The Municipal Commission of Singapore are considering a scheme for electric lighting.

Electric Printing.—The *Tyroler Tagblatt*, published in the Tyrol, is now printed by presses run by electricity.

Belfast.—An underground railway similar to those proposed in London is, we notice, being discussed for Belfast.

Brussels.—Six tenders have been received for the Brussels lighting. The result will be probably announced early in January.

Athens.—A telephone service is to be established in the spring between Athens and the Piræus, and the apparatus has been ordered.

Glasgow.—As will be seen elsewhere the Glasgow Town Council have reaffirmed their former decision in favour of the low-tension system of electric lighting.

South Africa.—The gold reefs at Heidelberg, South Africa, are once more attracting attention. The use of electric light both in the mines and town is rapidly being extended.

Asylum.—A new asylum for Staffordshire is to be erected at a cost of £100,000, containing all the latest conveniences, details of which are now being settled, including that of light.

Austrian Long-Distance Telephones. — The Austrian Minister of Commerce has announced that telephonic communication will shortly be opened between Vienna and Trieste.

Taunton.—A new phase has come over the situation at Taunton. The Lighting Committee consider it advisable to enter into negotiations for the acquisition of both gas and electric undertakings.

The Royal Society.—Amongst the papers read on Thursday before the Royal Society was one by Mr. G. T. Walker, on "Repulsion and Rotation produced by Alternating Electric Currents."

Artistic Fitting.—Mrs. Langtry has recently further adorned her very artistic residence with the electric light. This has been handsomely carried out, to special designs, by Messrs. Faraday and Son.

Wilderspool.—An agitation is on foot at Wilderspool and Stockton Heath, in the township of Appleton, near Runcorn, for better lighting of their streets. The Runcorn Local Authority have the matter in hand.

St. Ives (Hunts.).—The question of lighting this borough by electricity was introduced at the last meeting of the Council, and referred to a special committee to obtain information, and report at their next meeting.

Aluminium.—Why is not aluminium used in artistic fittings? This is a question being asked in scientific circles, and an alloy of aluminium and silver, making a new, elegant, and serviceable material for designers, is suggested.

City Men at Home.—Under this title the *City Leader* for November 28 gives an interesting and congratulatory personal article on Mr. Emile Garcke, the indefatigable managing director of the Brush Electrical Engineering Company.

Tender.—The Baths Committee of the Aston Manor Local Board are prepared to receive schemes and tenders for an installation in the baths by the 21st inst. Further particulars of Mr. W. A. Davies, engineer, Public Offices, Aston Manor.

Tyne Pilotage.—The Tyne Pilot's Committee have complained of the electric light at Rennoldson's engine works, South Shields, which prevented, they said, boats seeing each other until almost in collision. It was resolved to ask Mr. Rennoldson to shade the light.

Thunderstorms.—At the meeting of the Royal Meteorological Society next Wednesday, at 25, Great George-street, Westminster, a paper will be read by Mr. William Marriott, F.R.M.S., entitled "Report on the Thunderstorms of 1888 and 1889."

Visit to Welding Works.—A visit of the graduates' section of the East Coast Institution of Engineers will be made on Saturday next to the Victoria Engine Works of Messrs. Clarke, Chapman, and Co., when the electric welding plant will be shown in operation.

Scottish Engineers' Institution.—At the meeting of this institution on Tuesday, the papers read were by Prof. Jamieson, on "Brown's Rotary Expansive Engine," with diagrams and results of tests; and Mr. Ernest Scott, on "Electricity in its Relation to Mining."

Electric Medical Treatment.—A lady correspondent of the *Sheffield Daily Telegraph* has been to visit a new little hospital for treatment of diseases by electrical methods at Silver-street, Notting Hill. The treatment is gratuitous, and the methods used in the hospital are French.

Richmond.—At a meeting of the Richmond Town Council, held on the 8th inst., it was decided by a large majority to seal a contract with Messrs. Latimer Clark, Muirhead, and Co., Limited, Westminster, for the electric lighting of Richmond, Surrey, for a period of 30 years.

Paper on Electric Meters.—At the meeting of the students of the Institution of Civil Engineers to-night (Friday), a paper will be read on "Meters for Recording the Consumption of Electrical Energy," by C. H. Wordingham. Mr. W. H. Preece, F.R.S., in the chair.

O.S.A. Smoking Concert.—A most successful smoking concert was held on Friday at Masons' Hall Tavern. A first-rate programme was provided, and there was a large attendance of members and friends. The hon. secretary announced the names of no less than 27 new members and associates.

Chamber of Commerce.—A new list of members of the London Chamber of Commerce will be published in January. The reading-room was opened on the 23rd of last month. An employment department is being organised, and a temporary list of applications is issued free at Botolph House, Eastcheap.

Blackpool.—The minutes of the Blackpool Electric Lighting Committee of the Town Council were confirmed, recommending enquiries to be made as to electric lighting in other towns. Alderman M'Naughtan wished to speak upon the subject, but was too late, as the minutes had been passed. The matter was relegated to next month.

Ilkley (Yorks.).—Preparations are in progress for the promotion of a Bill in Parliament to empower the Ilkley Local Board to acquire the undertaking of the Ilkley Gas Company, and to construct new water works. The installation of a central station for supply of electricity for public and private lighting is included in the proposed Act.

Standard of Light.—The Board of Trade has undertaken to appoint a committee to consider a standard of light instead of the untrustworthy candle. The South Metropolitan Gas Company, of which Mr. Livesey is chairman, have undertaken to pay all costs. Dr. Frankland and Mr. Dibdin will represent the London County Council.

Bournemouth.—At the Bournemouth Town Council meeting the Bournemouth and District Electric Supply Company wrote asking for sanction to underground mains being laid in Clarendon and Marlborough roads, and to the road being opened for the purpose of putting in services to houses in Poole-road, Commercial-road, and The Square. Sanction was given.

Old Students' Association.—The next meeting of the Old Students' Association will be held at Finsbury Technical College on Wednesday, December 16, at 8 p.m., when a paper will be read by Mr. Rollo Appleyard, member, entitled "The Measurement of the Resistance of Conductors containing disturbing E.M.F.'s, with special reference to Earth Plates."

Rugby.—The gas works at Rugby are found hardly sufficient to meet the present demand, to say nothing of the new railway sheds and the natural growth of the town. The gas engineer is preparing a plan for extension, to be presented on the 18th inst. Electrical engineers might show the Town Council a way to enable the present works to be sufficient for the demand.

"Drehstrom."—We hear that the Allgemeine Company of Berlin are exceedingly busy with rotary current or "Drehstrom" motors, a large number of enquiries and orders for transmission plants having resulted from the Frankfort experiment. We understand that a small installation is being brought to England, and will be very carefully tested by Mr. Kapp.

Reading.—The Highways Committee reported to the Reading Town Council at their meeting last week that a letter from the Laing, Wharton, and Down Syndicate had been received giving an estimate for extending the lighting. It had been thought better that the letter should remain before them for further consideration, with the view of coming to a resolution next month.

Edison Secondary Battery Plates.—A solution is made by boiling litharge in a concentrated solution of caustic soda and potash. A lead plate boiled in this solution will receive a coating of spongy lead ⅛in. in thickness. This can be pressed down so as to occupy only one one-hundredth of an inch. A plate thus prepared yields readily to the forming process. This method, says the *Scientific American*, is due to Edison.

Electric Traction in France.—The Northern Railway Company of France, it is stated, will shortly make experiments with an electric locomotive on their line from Paris to Saint Denis. One of its characteristic features is that it will make use of the descents, on which a train requires no engine to keep up its speed, to put its dynamos in motion and thus restore to its batteries a portion of the expended power.

Coast Communication.—The Plymouth Chamber of Commerce have passed a resolution that a deputation should ask Lord Salisbury to vote £100,000 for coast telegraphic and telephonic communication, the Post Office to be asked to carry out the scheme in co-operation with the other interests involved. They also passed a resolution pressing on the Government the importance of the need of underground telegraph lines.

Keswick.—The inhabitants of Keswick have presented a petition to the Local Board, protesting against the erection of poles and overhead wires in Blencartha-street, as an eyesore and danger. The Streets Committee were instructed to inspect the streets. Keswick already rejoices in an example of the Brooks oil insulated underground mains, and it would seem that further mains on the same system would be appreciated.

Lighting a Channel.—The Town Council of King's Lynn, Norfolk, propose to light the passage from the sea to King's Lynn by gas-lighted buoys. Buoys of this nature have been lighted for some time in New York harbour by electricity with very good effect. They are bound to require less attention than gas, and will, no doubt, be eventually adopted in England in cases like that named.

Sheffield School Board.—A pleasant surprise awaited the members of the Sheffield School Board at their meeting last week, when the Board-room was lighted for the first time by electric light. The work had been done by Mr. Watkinson, teacher of electrical engineering and machine construction in the central school, and his pupils. The power was supplied from the gas engine used for driving the lathes in the technical school.

Electric Drilling.—Before the graduate section of the Institution of Engineers and Shipbuilders in Scotland on Tuesday, a paper on the "Application of Electricity to the Drilling of Metals" was read by Mr. Sinclair Couper. The author described by means of sketches the general construction of electrical drillers, and gave some useful information regarding the cost and speed of drilling by electricity as compared with hand drilling.

Nottingham Tramways.—An important communication was read at the Nottingham Town Council meeting on Monday from the Nottingham and Midland Merchants' Association. This set forth that the time was approaching when a reconsideration of the tramway facilities in Nottingham was desirable, and the adoption of cable or electric traction was suggested. The communication was referred to the Works and Ways Committee.

Theatrophone.—The theatrophone, the adaptation of the telephone by which private persons can have their opera turned on like gas and water, has been so great a success in Paris that an exhibition of it is to be given in London. M. Szarvady, the manager of the Compagnie du Theatrophone, has arranged for private demonstrations at the Savoy Hotel, when the instrument will be put in connection with the Savoy Theatre, and the "Nautch Girl" transmitted automatically.

Nelson (Lancs.).—The Gas Committee of the Nelson Town Council have resolved that the draft specification of the electric light scheme, as submitted by the gas engineer, be approved and printed, and that the town clerk should get tenders for the execution of the necessary work as soon as possible. The correspondence between the Board of Trade and the town clerk on the subject of electric light was also considered, and it was resolved that the action of the town clerk be approved.

High-Power Incandescent Lamps.—The Woodside Electric Company, of Glasgow, issue a pamphlet descriptive of their high candle-power, high-efficiency incandescent lamps. These range from 150 c.p. to 2,000 c.p. at two watts per candle-power. Statements are given of the comparative cost of arc and "Woodside" lamps, showing, beside the convenience, considerable saving by the use of the latter for lighting large rooms, halls, shop windows, ship hatches, warehouses, and so forth.

Smoke Prevention.—The golden days of London life are not yet, but they are coming, thinks Mr. Eric S. Bruce, who, in his lecture on "Fogs and their Prevention," at the St. George's Hall on Sunday described and illustrated the effects of the increasing consumption of soft coal. Not only by smoke-consuming grates, but more to the spread of electric heating, does Mr. Bruce look for the enlightenment of London skies. He concludes with the words, "Natural experiments with natural forces may be one of the duties of future governments."

The Chicago Exhibition.—Her Majesty, by Order in Council, has declared that the conditions of the Patent Act, 1883, under which an application for a patent is not to be invalidated by the exhibition of an invention at an international exhibition, are to apply to the Chicago Exhibition, and also that exhibitors are to be relieved from the conditions of the above Act, under which they were required to give notice to the Comptroller of Patents of their intention to exhibit the article afterwards sought to be patented. The regulations also apply to designs intended to be registered.

Electric Machinery.—Catalogue "B" of Messrs. Woodhouse and Rawson, Limited, deals with various electrical machinery, one section specially dealing with electric cranes, lathes, drilling machines, and motors for transmission of power. Various forms of Bolton's patent gear for electric cranes and winches are illustrated, cases being quoted where their application saved 8 h.p., or 43 per cent., over the rope-power traveller. Electric pumps and electric coal-cutters come in for their share of attention, and a magnetic ore separator, to separate 10 to 100 tons a day, is specially illustrated.

Rhondda Valley.—A large and influential meeting was held last week for the purpose of taking into consideration the question of the supply of the Rhondda Valley district, from Treorky Hotel down to Gelligaled, with electric light. Explanation of the system of electric lighting was given by several practical gentlemen, and it was unanimously resolved that steps be taken immediately with the view of securing a supply by means of a public company. A large and representative committee was appointed, and it was decided to thoroughly canvass the whole district, and have the result submitted to a further meeting.

Installation at Bombay.—Messrs. Ganz and Co., says the *Indian Engineer*, have just completed a small electric light installation at Admiralty House, Marine Lines, Bombay, the residence of Admiral Robinson. The installation is of peculiar interest, inasmuch as it forms one of the first electric light services that have been set up in private houses in India. Messrs. Ganz and Co. have also tendered for the electric lighting of the new municipal buildings, and the electrician of the firm, Mr. Archibald Crawford, has suggested that the engine and dynamo to be put up in the municipal buildings might also be used in the lighting of the town by electricity.

Prize Launches.—Mr. W. S. Sargeant, electric and steam launch builder, Strand-on-the-Green, Chiswick, has been successful in gaining the £25 prize offered by the Paignton Promenade Pier and Torquay Ferry Company for the best designs and drawings for the electric launches plying between Paignton and Torquay; also a 65 steam launch to carry 100 passengers for the proposed trip round Torbay, as follows: Paignton to Brixham, Brixham to Berry Head, Berry Head to Babbacombe and Torquay, running every two hours. These vessels are to be built in the best possible manner and to the Board of Trade's requirements, and to be delivered at Torquay on May 1, 1892.

Brighton.—At the Brighton Town Council last week the Lighting Committee stated a letter was read from Councillor Ballard suggesting a report showing all the streets to be lighted within the Corporation electric lighting area, estimated cost of mains, and how the outlying districts were to be supplied in case of the liquidation of the existing company. Alderman Reeves said an application was to be made to the Board of Trade for a company to come into the town, and it would be unwise to ask the committee to expose their hand. Councillor Moon said the information asked for had been given, and in case of liquidation of the company they were quite prepared with their plans.

Mansion Lighting in Ireland.—The electric light as a means of lighting private houses appears to be making headway in Ireland. We learn that the charmingly situated residence of Mr. J. J. Murphy, the well-known brewer on the banks of the Lee, is being lighted throughout on the incandescent system. The house and out-offices are being wired for about 100 lamps in all. A Robey engine is being put down to drive a six-unit dynamo of the Elwell-Parker type. A set of accumulators will also be used, so that the lights can be run when the engine is not working. Costly electroliers are in course of preparation for the reception-rooms to correspond with the general decorative appearance of the house. The entire installation is being carried out to specification by Messrs. J. K. Fabie and Son, electrical engineers, of Dublin.

Wednesbury Trams.—At the meeting of the Wednesbury Town Council on Monday, the application of the tramway company for an extension of time for the use of steam pending the substitution of electricity for steam power was granted, subject to the company paying or securing the payment within three months of the sum of £500, payable in respect of the improvement of Lower High-street. The Mayor explained that it was impossible for the company to make all the necessary changes in their plant within their limit of time, and it was of course very undesirable that the service should be stopped altogether and the public be deprived of the advantages which they had enjoyed from the use of the trams between Walsall and Wednesbury. The town clerk added that the company had forwarded an undertaking to pay the £500 within two months.

City Lighting.—By the fuss which has been made over the City lighting at the Commissioners of Sewers, people might almost be led to believe that some insuperable difficulty was before the engineers in lighting the City. The contractors to the City of London Company are progressing rapidly, and we believe it is now expected that the Laing, Wharton, and Down section of the district will also have lights running in a week. The machinery is being rapidly got ready, while the mains have long been laid. A curious accident occurred at these works which caused a little delay. During the violent storm of a month ago some 30ft. of the new chimney was blown down, and had to be rebuilt. In the Brush Company's station the alternators are running, and, as we mentioned a little while ago, trial transformers are being tested in the Queen Victoria-street subway.

Lambeth.—A letter was read from the secretary of the House-to-House Electric Light Supply Company at last week's meeting of the Lambeth Vestry, offering to transfer to the Vestry the electric order of the company at a price equivalent to the estimated cost of obtaining a new order by the Vestry. Mr. King explained that the Electric Lighting Committee had considered this communication, and had had the secretary of the company before them. After some debate, the secretary offered to transfer the order to the Vestry free of charge, but the committee felt that they ought not to be under an obligation to the company, and resolved to decline the offer. Mr. White enquired as to the probable rate of interest at which a loan could be secured for lighting purposes. He noticed that the County Council wanted to make St. Pancras pay 4 per cent., which he thought was too much. He should move a resolution on the subject at a future meeting. The Vestry decided to decline the offer.

Church Lighting at Newcastle.—St. George's Church, Newcastle-on-Tyne, has recently been fitted with the electric light in place of gas, and the new illuminant was used for the first time on Sunday evening, the 29th ult. The nave, chancel, baptistry, and morning chapel are lit by 128 Edison-Swan incandescent lamps. These are arranged in groups of eight, in handsome electroliers of hand-wrought copper and brass. There are other lights in the vestry, pulpit, and organ. The effect of the light has been found satisfactory and pleasing. It shows off to advantage the beauties of the architecture and decorations of the church, while the purity of the light and freedom from smoke and fumes will do much towards preserving the rich colouring and gilding of the latter. The work was carried out, the gas taken away, and the electric light fitted without causing any break in the continuity of the services. The adjoining parish hall has been lit, and the whole of the work, which is of a most satisfactory nature, has been carried out by Messrs. R. J. Charleton and Co., electrical contractors, Pilgrim-street, Newcastle.

Ulverston.—The Town Council of Ulverston are still somewhat in a quandary as to the introduction of the electric light now or hereafter. A committee, consisting of Mr. Tosh and the town clerk, had an interview with Mr. Courtenay Boyle, of the Board of Trade, with reference to their electric lighting order. Mr. Courtenay Boyle stated that the order was in its form obsolete, as the price empowered to be charged was not sufficient. He suggested the Board should consent to the revocation of the order, and should apply for an amended order when it was found desirable to supply electric light. The profits from the gas works at Ulverston are pledged by the rates so far as regards annuitants, and the Council do not naturally wish to decrease these profits, but the storage of gas is sometimes not more than two hours' supply, so that something must be done shortly. It was understood that the Board of Trade would refer outside applications to the Ulverston Local Board, and that these applications would not be allowed unless there was a distinct desire on the part of a majority of the ratepayers for the adoption of the electric light.

An Electric Sidewalk.—We mentioned a few months ago a bold invention in the shape of a moving sidewalk, operated by electric power, and we are given to understand that a specimen in working order will probably be one of the features of the coming World's Fair, installed by the Columbian Movable Sidewalk Company, of Chicago, which owns the patents. A contract has been entered into with the Thomson-Houston Electric Company for the electrical and steam equipment. All the mechanical and electrical plans and details have been worked out by Mr. G. K. Wheeler, of the Thomson-Houston Company, and the entire plant will be installed under his supervision. This sidewalk is to be erected on a structure 25ft. high and 900ft. long, in the form of an ellipse, and is to consist of 75 cars, each 12ft. long, coupled together, making one solid train. There are to be constructed two parallel sidewalks, one running at the rate of two miles an hour, the other at four, both moving in the same direction. The passengers can step from the stationary walk to the one which moves at the rate of two miles an hour, and if a swifter ride is desired they can step to the walk running four miles.

Electric Fitting Manufacture.—The rush for electric light in the best private houses in London, is making itself felt amongst manufacturers of lamps and gasfittings more than ever. We have alluded to the energy of Messrs. D. Hulett and Co., of Holborn, with whom Mr. Arthur Cockburn has been connected as managing electrical engineer, and Messrs. Emmanuel, of High-street, Marylebone. This latter firm are engaging a new staff of men, and laying themselves out for considerable and extended supply of electrical work. Mr. C. G. Gill, manager with Messrs. Strode and Co., has recently arranged to join Messrs. Emmanuel, so that an opening for an enterprising business man with good knowledge of electricity is likely to occur at the firm he is leaving. We learn also incidentally that the well-known firm of Defries and Co. are intending to go in somewhat strongly for electric light—having made themselves celebrated in oil they evidently long, like Alexander, for other worlds to conquer. They have plenty of capital and experience, and if combined with a good electrical man of business, they should receive their share of the enormous trade which the genius of Edison and Swan has evoked.

The Smithfield Show.—The usual excellent collection of engines was to be seen at the Agricultural Hall this week; Robey's, Hornsby's, Ransomes, Sims and Jefferies, John Fowler and Co., Ruston and Proctor, and Marshall, Sons, and Co., all being well represented so far as steam went; while Crossley's gas engine, Priestman's oil engine, and the Hornsby-Ackroyd oil engine were also in evidence. Messrs. W. H. Willcox and Co., of Southwark-street, showed their lubricating oils, engine packings, and engineers' sundries. Machine belting, especially the leather class, was well represented, there being numerous exhibitors. Among these were the firm just mentioned, the Gandy Company, Hooke, Haagen, and Norris. Mr. C. L. Hett, of Brigg, had an exhibit of turbines, to the manufacture of which he has devoted considerable attention. Mr. Hett supplied the turbine used in the Studley Royal installation, Yorkshire. He has also brought out a centrifugal pump, the suction branch of which can be swivelled to any angle without interfering with the delivery—a useful improvement. The newest thing in the exhibition was paint, of which, by the way, one well-known firm has adopted a brand-new colour, so far as engines are concerned.

Disinfecting Ships.—To few situations has electricity proved so useful as to the ocean steamships—those floating circumscribed hotels in which luxury is carried to its utmost extreme, and where scrupulous healthiness is indeed absolutely necessary. The electric light itself was sufficient of a boon to make all the difference between comfort and discomfort. Added to this, the little electric motor fans, to secure that so necessary concomitant to healthy living—pure air in the rooms. Nor is this all, for it is now proposed to use electricity for the disinfection of ships. By the electrolysis of sea-water chlorine gas is liberated, and the oxidation of noxious substances is produced. The gas would be distributed in pipes to those portions of the ship requiring it, from an electrolytic bath, the current used being that of the ship's dynamo. It has been seriously proposed to freshen and purify towns by sluicing them with electrolysed water—a problem of considerable extent indeed. But if such purification proved useful on board ship, as seems to be thought probable, the experience so gained might conceivably lead to use on larger scale elsewhere—for hospitals, stables, slaughter-houses, or even more publicly. The usefulness of electricity in sanitary matters is so little realised that it is worth the while of sanitary authorities and engineers to accord every encouragement to new tentatives in such a direction.

Canterbury.—The draft agreement of the Brush Company with the Canterbury Corporation contains stipulations that the Brush Company will form a Canterbury Electricity Supply Company, Limited, with a capital of £50,000, preference in the allotment to be given as far as possible to local residents. To this company shall be conveyed by the Corporation all their powers, duties, liabilities, and works under the order. The Corporation to have power to purchase the undertaking at the expiration of a period of 21 or 31 years, on payment of the value of the plant and goodwill as a going concern purchased by compulsion, such value to be determined in case of difference by arbitration. The Corporation are further required to bind themselves not to apply or support the application of others for a further authority under the Electric Lighting Acts during the continuance of the order. The price to be paid to the Canterbury Electricity Company for all energy supplied to the public lamps to be settled by agreement or arbitration. The Brush Company are to pay a deposit of £35 upon the signature of the agreement, and "unless on or before the 1st day of May, 1892, the consent of the Board of Trade shall have been given by the proposed transfer and unless on or before the 1st day of June, 1892, capital in the Canterbury Company of the nominal value of at least £15,000 shall have been subscribed and allotted, either party to this agreement may, by notice in writing to the other, determine the same." Clauses will be inserted to safeguard the Corporation in case of the collapse of the company. A maximum is not fixed, but, on the other hand, the company have no guarantee, and have the opposition of the gas company to make their prices moderate.

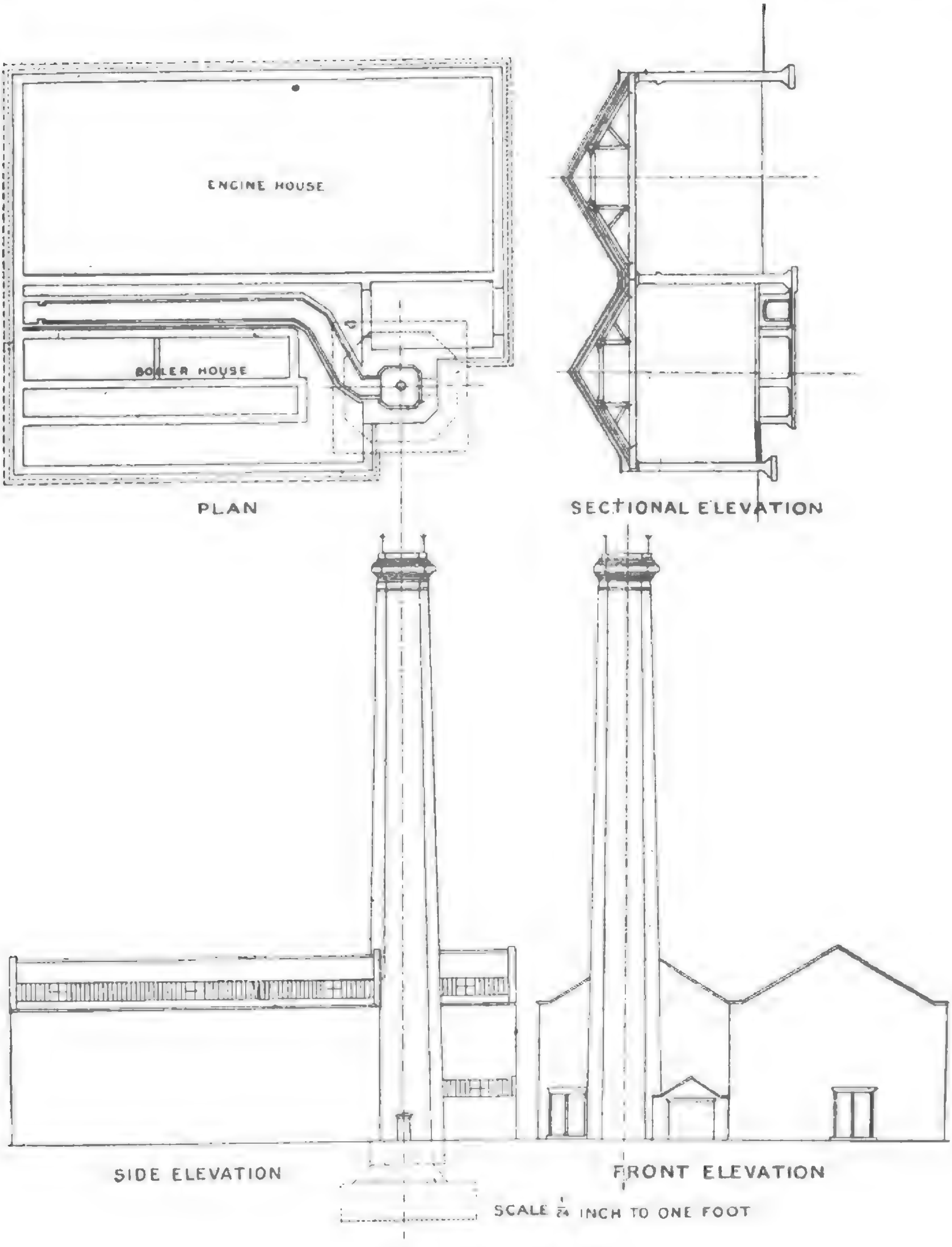
Electric Railways in London.—In the ensuing session Parliament will be asked to legislate upon four new schemes for underground railways to be worked by electricity. 1. A railway to be called the Great Northern and City Electric Railway, which is intended to commence by a junction with the Finsbury Park and Canonbury branch of the Great Northern, passing underground and terminating in Finsbury-pavement. 2. A railway to be named the Waterloo and City Electric Railway, running underground and passing beneath the bed of the Thames from Waterloo Station to the Mansion House. 3. An underground railway commencing in the vicinity of New-street, Upper Baker-street, and passing, *vià* Langham-place, the quadrant by the County Fire Office in Regent-street to Waterloo. 4. An extension of the City and South London Railway from the City-road to Islington. It will be remembered that under the scheme proposed by Mr. Mott last year it was not intended to effect an actual junction with the existing railway in the City, but to have a subway for foot passengers connecting the two sections. This, however, was rejected by a committee presided over by Mr. Hanbury. Some material amendments have, however, been made in the scheme, under which it is proposed to form a connection with the existing line, thus removing one of the main objections put forward by the opponents last session. The new scheme also differs from the rejected scheme by providing a subway for foot passengers from the north end of Fish-street-hill to the proposed extension line, whilst powers will also be sought to connect, by means of another subway on the Surrey side of the river, the existing railway with the London Bridge Station of the London, Brighton, and South Coast Railway Company. The Central London Railway Company also intend to apply to Parliament for power to extend their line, which was authorised last year, to Liverpool street.

Laing, Wharton, and Down's Fire.—We paid a visit the other day to the scene of the fire at Messrs. Laing, Wharton, and Down's works near New Bond-street. The premises stand back up a small court off Brook-street, and the entire works were gutted from top to bottom. Fortunately the firm were insured, though not for the full value, as it is their habit to reinsure at an additional sum in December, and it was within 10 days of this time. A damage of some £8,000 was caused, and this not including £2,000 worth of property, such as candlesticks, candelabra, and other fittings which were being altered, many belonging to the aristocratic houses of the West-end, costing 50 or 100 guineas each. The view as we saw it was one of desolation, clearing having to be left for several days on account of the contraction of rafters. Heaps and masses of blacked and charred material, amongst which enamelled shades, switches, fittings, name-plates, brass tubing, and all the *omnium gatherum* of an engineer's shop, were confusedly heaped together. The roof is open, and the iron rafters bent and twisted, the shafting distorted, and the woodwork charred almost through. Yet the fire did not last more than an hour and a half after starting. Mr. Down immediately took fresh premises, which he was fortunate in getting close by, put down a gas engine and half a dozen lathes, with some saved from the fire, and in a day or two had his works going as before. They are clearing out the burnt remains of the original works, and will rebuild. Messrs. Laing, Wharton, and Down state that they received great kindness and many offers of help from other electrical firms, and convey their thanks. It is a curious fact, owing to the advertisement given by the fire, or possibly coincidence, that the amount of orders received very greatly increased at the week of the fire. They are now practically in the position to execute work as before.

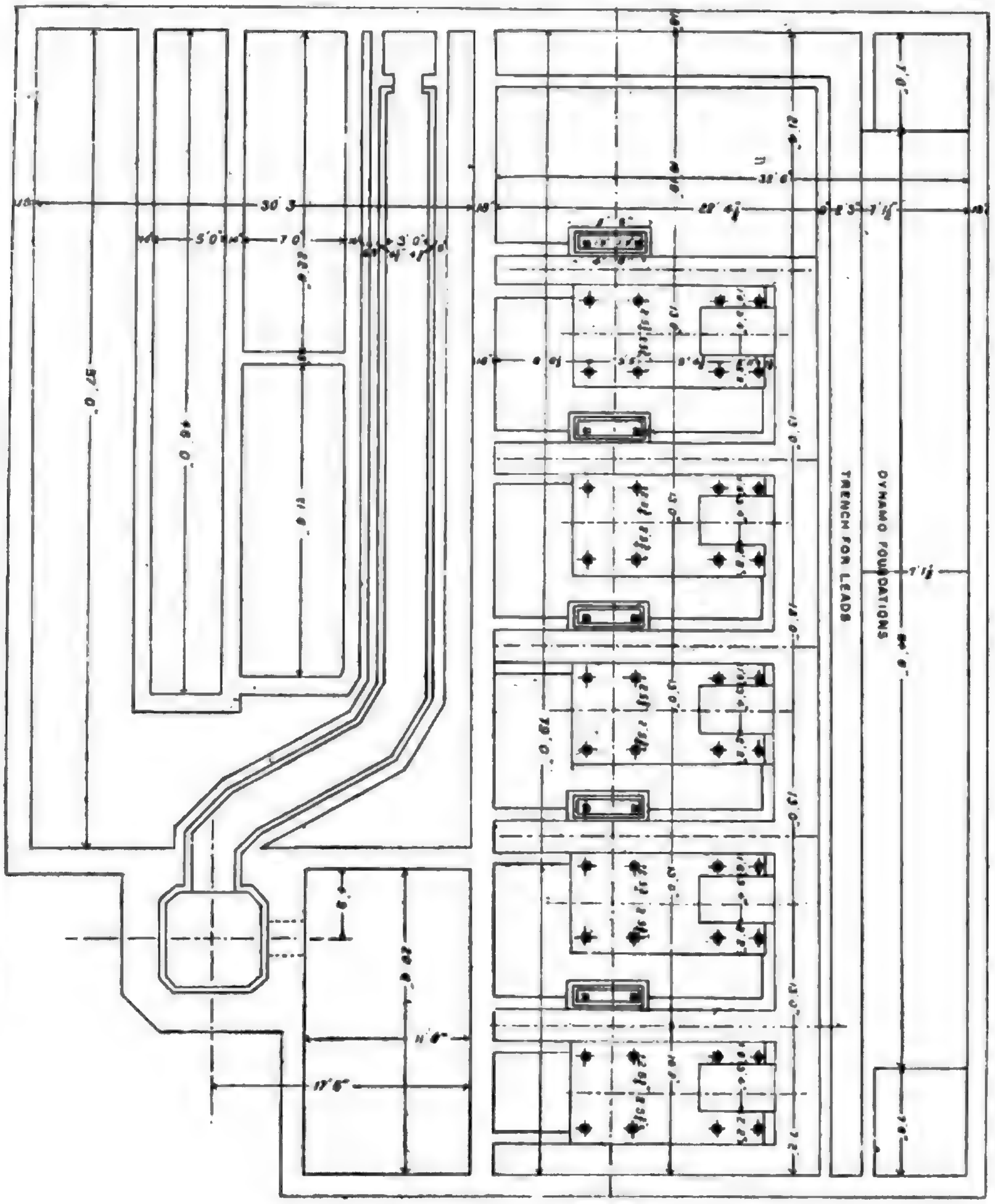
The Roundhay-road Electric Tramway.—At a meeting of the Tramways Committee of the Highways Committee of the Leeds Corporation, held on Tuesday, Mr. Graff Baker requested that the electric tramway lines should be extended from Green road down Beckett-street to the junction of York-street and Kirkgate, in accordance with the provisional order of 1888. The committee decided to recommend the Highways Committee to make the extension. If the recommendation is adopted, Roundhay Park will become much more accessible from the centre of the town than it has been hitherto, and the people living in the Burmantofts district will be brought into closer touch with other parts of the borough. At the same meeting a deputation from the National Telephone Company attended to complain of an interference with their telephone system by the return current of electricity on the Roundhay-road line. It was stated that Dr. Hopkinson and Mr. Winterbotham, solicitor, who represented the interests of the telephone company, pointed out that the electric current made a buzzing noise in the telephone, and that operators could even distinguish when a car was on the line, and when it was ascending an incline. Between 20 and 30 users of the telephone living beween Sheepscar and Roundhay say they cannot hear anything said to them, and the telephonic authorities allege that the cause arises from the interference of the telephonic currents by the tramway currents, and that the construction of the tramway system is faulty. Mr. Baker and Mr. Winslow, who attended on behalf of the lessees of the electric tramways, replied that their currents are laid and their cars worked exactly as they are in America, where they never interfere with the telephones. To this the representatives of the National Telephone Company rejoin that the adoption of a simple and inexpensive preventive expedient when the tramways were constructed would have rendered the mischief now being complained of impossible. The committee, having heard all that both parties had to say, decided to leave the two companies to settle the matter between them.—At a further meeting of the Leeds Highways Committee on Wednesday the recommendation of the sub committee that the electric line should be extended was unanimously agreed to, and it will now come before the Council for confirmation.

THE SYDENHAM ELECTRIC LIGHT STATION.

In our issue of October 23 we recorded the laying of the foundation-stone of a new central station for the Sydenham district. The station is being built and fitted by Messrs. J. E. H. Gordon and Co., to the order of the Construction and Maintenance Company. Our most recent visit to the works was on Saturday last, when Mr. Todd, who is actively superintending the due execution of the work, explained what had been done and what remained to be done. There is little doubt but the station will be ready to supply current at the opening of the Crystal Palace Exhibition on January 1st, 1892. Three boilers were in position, and a fourth was at the door, the fifth being at the railway station, so that before the time this notice appears in type the five boilers will be in position, and three of them ready for steaming, as will be at least two engines. The time has come, therefore, when a complete description of this new station may be given. In our issue of to-day we commence the necessary illustrations for such a description. These will be

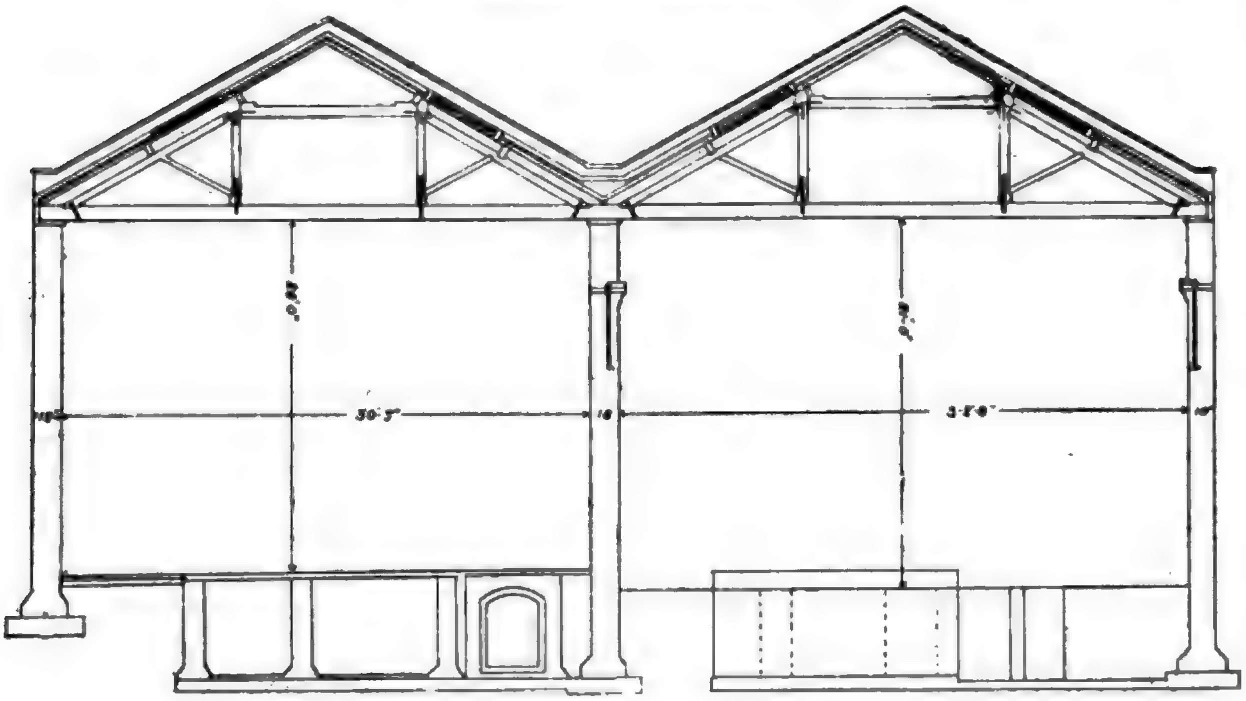


Sydenham Electric Light Station.


TRENCH FOR LEADS
DYNAMO FOUNDATIONS
30' 3"
57' 0"
46' 0"
35' 6"
17' 6"
11' 6"

Scale $\frac{1}{16}$in. to one foot.

SYDENHAM ELECTRIC LIGHT STATION.—GENERAL PLAN OF FOUNDATIONS.



followed from week to week till the whole have been presented to our readers, who will then have the most complete record of any central station that has ever been given.

SOLAR STRESS CONSIDERED AS THE CAUSE OF TROPICAL HEAT.

BY R. C. SHETTLE.

In my paper published in the *Electrical Engineer* on December 4, I suggested that "solar stress was the cause of tropical heat." I now wish to supplement that paper with a few remarks from a dynamical point of view.

I considered tropical heat as the result of the elastic energy of the atoms, manifested owing to reduction of terrestrial gravitation pressure in the line of the greatest solar stress. The question may be asked: If reduction of this pressure is in proportion to solar or any other external stress, how is it that the moon does not produce more heat than the sun, as its gravitation stress is greater?

In answer to this another element comes in—viz., the results of the *motion* of bodies in the production of magnetic phenomena, and the consequent effects which they manifest upon each other. Thus, "no particle of matter is independent. . . . Every atom of matter is in the place and under the conditions it occupies, as a result of the sum of the various forces which influence it."*

Again, "magnetic force varies in electromagnets according to two ratios: 1. As the number of turns of wire. 2. As the current passing. We may put the two ratios together and say it varies as the current-turns; or, carrying out the regular evolution of technical terms, we may say, in a given magnetic system the force varies as the ampere-turns."*

Now, in addition to the internal magnetic effects upon the earth, etc., by ordinary statical gravitation, we must take into consideration the dynamical conditions, all of which are modified by the nature of the component elements of each mass. We then find that in proportion to the mass, its nature, and the number of rotations, the stress is increased; the character of each atom in this case adding to the dynamical in contra-distinction to the statical effects of stress. Therefore, as the sun is so much larger than the moon, and its magnetic condition so much more active, owing to its mass, the rapidity of its motion and the amount of stress to which it is subjected from a variety of sources, its effects upon the *rotating earth* ought to be much greater than those of the moon.

A MOTOR OPERATING AUTOMATICALLY AT ANY DESIRED SPEED OR TORQUE AND WITH MAXIMUM EFFICIENCY UNDER ALL CONDITIONS.

BY H. WARD LEONARD.

In the operation of electric motors there are three principal factors to be considered—the speed, the torque, and efficiency. Under any variations in power the efficiency should remain as nearly constant as possible. For one class of work it is desirable to keep the speed constant when the torque varies. For a second class of work it is desirable to keep the torque constant at one particular amount when the speed varies. For a third class it is desirable to operate at many different speeds, and yet automatically at any particular speed desired regardless of the torque. For a fourth class it is desirable to operate at many different torques and yet automatically at any desired torque regardless of the speed; and for a fifth kind it is desirable to keep the amount of power supplied constant, regardless of a change in torque—that is, so that if the torque changes by the requirements of practice, the speed would automatically change so that the power consumed would remain constant.

The shunt-wound motor, operating on a constant-potential circuit, is well adapted to the first class of work mentioned, where but one fixed speed is desired, practically regardless of the torque and with a practically constant efficiency.

The second class of work mentioned, having one particular constant torque and a speed variable at will, cannot be performed by existing electric motors without great sacrifice of efficiency. In this class of work we find hoists lifting a constant weight, certain printing presses, swing bridges, stamp mills, pumps, etc.—that is, such work as requires that we should start up from dead rest with full torque and run at any desired speed with the same torque and with perfect efficiency.

The third and fourth classes of work are more common than would at first appear evident, but since neither the steam engine nor the waterwheel can be operated under conditions where both speed and torque will vary, and where the speed or torque can be held automatically fixed at any point desired, regardless of variation of the other, we do not find work of this kind existing in such shape as to be operated by an electric motor instead of some other power. Nor has the electric motor been available for such duty heretofore. A familiar instance of the third kind of work is met with in the printing of fabrics, where the presses have a large number of rolls upon which the torque depends, and the speed of the presses must be varied as desired, and yet at any given speed must hold that speed constantly regardless of the number of rolls set down—that is, regardless of the torque. Similarly, lathes, drill presses, wood-working machinery, etc., belong to this class. Certain variations in the speed are possible by existing methods by the use of the cone pulleys and equivalent devices, but no motor of any kind has heretofore existed which directly applied could conform to the requirements of this kind of work.

The fourth kind of work has, as a familiar example, the passenger elevator, where the weight, and consequently the torque, is variable, and where at any torque the speed should be controllable at will with constant efficiency. Another example is the pumping of water against a variable pressure with the speed controllable at will, and independent of the pressure. This result is not obtained directly by any motor to-day.

The fifth class of work, where the speed is automatically varied to keep the power consumed constant, no matter how the torque varies, is not met with in practice as far as I know, yet oftentimes we may have a constant source of power from which we wish to get a torque variable to the requirements of a variable load and do not care particularly about the speed. An electric street railway operated by water power is a familiar example of this class of work.

It will be seen from the above that of the five principal classes of work there is only one—namely, constant speed and variable torque—which we can take care of with reasonable efficiency and from our existing supply circuits.

It is well known that when a street car is first started and is scarcely in motion the actual power represented by such motion is almost nothing, for, although the pounds pull is large, the feet per minute is extremely small; consequently the power required must be exceedingly small. What do we find in practice? We find that in order to develop a power of but a fraction of a horse-power we must, on account of the slow speed demanded, develop about 30 h.p., and then waste about 98 per cent. of this horse-power in order to utilise the remaining 2 per cent. in the way it is desired. The efficiency of the modern electric street car is not probably more than 2 per cent. when just starting from dead rest and moving at the rate of one-half foot per second.

When we come to investigate this, we find that the explanation is that in order to get the necessary large torque with freedom from excessive sparking, we must have a very large current in a nearly constant field; and since our E.M.F. is constant, we must use an amount of power which will vary almost directly with the torque, and will be regardless of the speed. Or, in other words, the efficiency of the motor will vary directly as the speed, with an efficiency of perhaps 80 per cent. at full speed.

As a result of my investigation of this subject, I have concluded that the operation of electric motors should conform to what apparently is a new law, and which may be stated as follows: Vary the voltage as the speed desired; vary the amperes as the torque required.

In other words, make the speed dependent upon the voltage only and independent of the current, and make the torque dependent upon the current only, and independent of the voltage. Since the product of the speed and torque represents the work being done, and the product of the volts and amperes represents the power supplied, it is evident that if we can operate in conformity to this law, we shall have a constant efficiency under all conditions, disregarding, of course, the small fixed losses in the field and armature.

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* "Electricity," J. T. Sprague, pp. 481 and 510.

One way in which this law can be followed is to supply the field of the motor from one source of electric energy and supply the armature from another source, the E.M.F. of which can be varied. It will be noticed that when the speed is fixed a fixed voltage will be necessary in order to conform to the law, and the shunt motor is found to conform perfectly to the law; but it is the only motor I know of which does conform to the law which seems to be generally applicable.

A simple case will be the operation of a printing press for printing fabrics. Suppose the press has 10 rolls—that is, the torque will vary from one to 10 in amount. Suppose also that it must be run at any speed from that represented by one to that represented by 20, and at any speed it must hold its speed constantly, whether one or 10, or any intermediate number of rolls be brought into use. Also that the efficiency must be independent of the speed or torque. In order to conform to the law in a simple way, we will install a generator and motor of the same size and connect their armatures by two conductors. We will supply their fields from a small separate exciter in the shape of a shunt-wound dynamo. In the circuit leading to the field of the generator we will place a rheostat. If now we drive our generator at a constant speed, the E.M.F. it will produce will depend upon its field, which in turn will depend upon the amount of resistance in the rheostat in its field circuits. The strength of the motor field is constant, being supplied by the constant E.M.F. exciter. Now, evidently the speed of the motor will depend solely upon the E.M.F. supplied to its brushes, and this can be varied from 0 to the maximum limit by varying the rheostat, which will preferably be placed beside the motor itself. The current will automatically vary in proportion to the torque, the speed will vary directly as the voltage, and the efficiency will be constant and independent of the speed or torque.

If we wish to operate an elevator from central station conductors of constant E.M.F., we supply a shunt-wound motor mechanically connected directly with a generator, whose armature is connected to the armature of the elevator motor. The field of the generator is supplied from the central station conductors, but a loop goes up to the elevator car, where a rheostat and reversing switch are placed, so that the E.M.F. of the generator can be varied and reversed at will. The field of the elevator motor is excited from the line constantly.

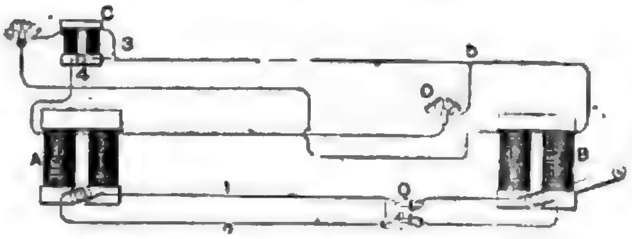
It will be evident that we can control the elevator perfectly from the car and run in either direction, at any desired speed, and with perfect efficiency. It is worthy of notice that the non-sparking point is entirely independent of the speed, and that for any particular weight the non-sparking point is absolutely fixed and independent of the power used. Also that, since the maximum weight alone determines the maximum amperes, it will be impossible to send more than the normal full load in amperes through the armature; consequently the liability of burning out of armatures is reduced to a minimum. The elevator in coming down generates current to assist the central station, and since the efficiency is practically constant under all conditions, and since as many foot-pounds of work are done by the elevator in descending as it requires in ascending, the consumer will in reality pay only for the energy wasted in charging the fields, in heating the armatures, and that represented by the friction of the gearing, which will be the least possible. The starting up of the elevator requires a minimum of power, and hence does not subject the central station to large, sudden fluctuations of load.

Suppose we want to operate a swing bridge by an electric motor. We connect, as in the case of a printing press, but instead of a hand field rheostat we use an automatic field rheostat, such as is used by the Edison company. We place an ampere-meter in the armature circuit of our motor, and when the ampere-meter needle indicates full load it touches a contact leading to the relay magnets of the automatic rheostat, which causes it to throw in resistance in the field circuit of the generator and reduces its E.M.F. Similarly, just below full load, the ampere-meter needle makes contact, closing a circuit in the automatic rheostat so as to throw out resistance and raise the E.M.F. of the generator.

To start up the bridge we insert all of our resistance in the field of the generator, and have, let us say, no volts. Now we close the main line switch to the motor. We will have no current, hence the ampere-meter needle will be on the lower contact, which will gradually throw out resistance and cause the generator to generate an E.M.F. The current will increase, and will finally cause the needle to leave the lower contact. The full torque is now being developed, and the bridge, if the motor be of proper size, will start to move. As it does so the counter E.M.F. of the motor will tend to reduce the current, but this will cause the needle to again make the lower contact and raise the E.M.F. and speed and hold the current and torque constant.

Thus the bridge will start from rest with a minimum of power but full torque, and will gradually accelerate in speed until the full E.M.F. and speed of the motor is reached. To vary the speed by hand we merely move the ampere-meter needle to make either contact desired. In case the bridge should meet an obstruction which would slow it down, the amperes would not increase, but would remain constant, as the volts would be immediately and automatically reduced to just that amount necessary to keep the amperes constant. With this arrangement it will be practicably impossible to overload the motor armature.

Another good application of this method of keeping the torque constant will be in any case where a tool is cutting certain material which may vary in hardness, or when the feed may vary. If the torque be kept constant it will be impossible to break the cutting tool or injure the apparatus. An electric coal-cutter is a case in point. The cutter may be advancing through slate, fireclay, or coal, and occasionally it will meet a layer of hard iron pyrites, known in the mines as "sulphur." This may stop the cutter-bar entirely, and with an ordinary or series or shunt motor the result would probably be a burnt-out armature. With the system I have described the current would be constant in any event, and the current would automatically go faster in soft material and slower in hard material.



Leonard's Automatic Motor.

In pumping by an electric motor operated on this system the head alone determines the torque, and hence the current. Consequently, for any lift the none-sparking point will be fixed, and the number of strokes per minute can be controlled at will, from 0 up to the maximum by varying the volts.

For operating an electric railway we will place a shunt-wound motor on the car, and directly driven by this motor will be a special generator, which will be connected to the electric motor below the car. It is evident that the generator and working motor armatures may be wound for any voltage desired, say 20 volts, which will make the problem of insulating the street car motor an extremely simple one. If desirable, we can supply several cars of a common train from one special generator on the forward car. With this outfit we will be able to take any car up any practicable grade or around any curve with no more power than is required to move the car on a level, and always consume the same power, regardless of weight, grades, or curves. That is, the automatic increase of current, to take care of any increased torque, will be compensated for by a corresponding decrease in the volts and speed. We may start a car up on any grade or curve with but a small fraction of the power required for normal speed on a level.

I wish to call attention to a very important development leading out from this—namely, that we will be able to use alternating currents for operating our street cars, for it is well known that the ordinary alternating-current generators will operate perfectly as motors, if the speed and torque be kept constant. Since by this system we can, from a constant torque and speed, get any other torque and, automatically, a corresponding speed, we shall be able to run street cars perfectly by alternating currents. This, again, will enable us to dispense with trolleys, conduits, storage batteries, etc. We will place between our tracks, in manholes, converters whose primary pressure can be anything required for proper economy and whose secondary will be, say, 15 volts. This secondary circuit will connect directly with the rails. The road will be divided in sections, each a few hundred feet long, and each section will be supplied by its own converter.

This system also lends itself very readily to the transmission of power. We may transmit by alternating currents, and the alternating-current motor running at a constant speed and at a nearly constant torque will drive special generators to operate hoists, pumps, locomotives, etc., at the varying torques and speeds demanded by practice, and yet without subjecting the alternating-current motor to a sudden or wide fluctuation in its torque and without any necessity of varying its speed. With this system of operating electric motors there seems to be no work met with in practice which cannot be perfectly performed.

On first consideration, the additional apparatus necessary would seem to make the system prohibitory in practice; but the capacity of the present single motor is greater than the combined capacity of the apparatus this system would require, and the capacity of the prime motor is very much reduced.

In order to reduce the first cost to a minimum and yet secure the advantages of different automatic speeds and high efficiency, I have devised two modifications of the arrangement described above. The first is adapted to power in which a smooth, efficient acceleration of a load from rest is required, as in the case of passenger locomotives and elevators. The second case is where various automatic speeds are desired, but no especial importance attaches to the starting of the load from rest, as is the case in machinery in general.

For the first case we have the trolley system of electric street cars as the most important. Let us suppose we have two motors of 15 h.p. each for the car. We find that for full speed upon a level we require about 15 amperes at 500 volts. Upon heavy grades we find that about 50 amperes are required, and, as before, we have 500 volts. With this consumption of energy we find that we get a speed upon the heavy grade which is about one-quarter of the speed upon a level. In order to operate upon my system, let us place upon the car a motor generator, the motor part of which is wound for 500 volts and 12½ amperes and the generator part of which is wound for 125 volts and 50 amperes. The fields of the motor and generator part are distinct, and are wound for 500 volts, as are the fields of the two propelling motors under the car. All these fields are supplied from the 500-volt trolley circuit. In the field of the auxiliary generator is placed a rheostat.

Now, suppose the car at rest upon a grade. The motor generator is running, but the generator has a very weak field. Its armature is connected by a controlling switch to the propelling motors. We now gradually cut out resistance from the generator field circuit, and finally get about 20 volts at the brushes of the generator. With this E.M.F. we get sufficient current to produce 50 amperes through the armatures of the propelling motors in a saturated field. This gives us the full torque, and the car starts at a speed of perhaps half a foot a second. This speed can be maintained constantly and indefinitely, and the consumption of energy will be less than 2 h.p. This is less than three amperes from the trolley line. In practice, however, the speed will be rapidly but gradually accelerated, until we have 125 volts upon the terminals of the propelling motors. We will now be running at one-quarter speed, and will be consuming 125 volts and 50 amperes—that is, 6¼ kilowatts instead of 25 kilowatts to get the same result with existing motors. To put it another way, we will not be using as much energy as is represented by the 500 volts and 15 amperes necessary for full speed on a level.

The next step on the controlling switch will disconnect the armatures of the propelling motors from the auxiliary generator and put the two armatures in series across the trolley line direct. We will now go at a speed represented by 250 volts—that is, one-half full speed. The next step of our switch will place the two armatures in multiple across the 500 volts, and the next and last step will place the 120-volt auxiliary generator in series with the main central station generators, and give us 625 volts on our armatures and a correspondingly increased speed. We will be able to go up a grade of 6 to 8 per cent. at full speed, with 50 amperes and 500 volts, which, with the present motors, gives only about one-quarter of that speed.

Under this arrangement it will be noticed that the only apparatus which could be called additional is the small motor of 500 volts for the generator part of our motor generator, which is useful, not only for starting, but for full speed also. In stopping the car we have an electric brake action delivering back energy to the line at full efficiency and not through a rheostat, as at present.

If we have a train of, say three cars, so that we have six motors, we can start from rest with sufficient smoothness by placing all six armatures in series, which will give us something less than one-sixth speed as the first step. Then we can place three in series with two multiples, which gives us one-third speed. Next, two in series with three multiples, which gives us one-half speed ; and finally, all in multiple, which gives us full speed. Under such conditions, we can dispense with the small converting plant altogether.

For an elevator requiring, say, 15 h.p. we will put in a motor generator of 3 h.p., with which we will control the starting and stopping and the operation up to one-fifth of full speed. Then for full speed we will connect direct to the line and operate without any conversion of energy.

For power in which smoothness of motion in starting and stopping is not essential I have devised a new system of distribution, as follows: three dynamos all having the same current capacity and having voltages of 62½, 125, and 250 respectively, are placed in series and from conductors led off in multiple, one from each terminal of the machines. These conductors will have potentials which can be represented by 0, 62½, 187½, and 437½. Let us now take a shunt-wound motor, and, disconnecting the field from the armature circuit, excite the field from the outside two of the four conductors, that is, by an E.M.F. of 437½ volts. By connecting the armature terminals to the four conductors in various ways we shall be able to operate in either direction at six different automatic speeds represented by the following voltages: 62½, 125, 187½, 250, 275, 437½. By varying the field strength of the motor we can, if required, get any intermediate speed.

In many cases two dynamos will answer, one of, say, 110 volts already in use for incandescent lighting, and a second of, say, 30 volts. With this arrangement we could run in either direction and with automatic speeds represented by 30, 110, and 140.

With the four-wire six-voltage system of distribution in a shop we can take out all countershafting, belting, pulleys, and gears, if desired, and place a motor upon every tool, which we can operate in either direction at any automatic speed desired. Lathes, planers, and all tools can be perfectly operated, and by getting rid of all countershafts and belts we can introduce the greatest of modern tools, the travelling crane, which we will also operate from our general system. We can also readily operate ventilating fans, hoists, elevators, and factory tramways from the system.

The addition of one dynamo and one new conductor to any existing three-wire system will probably give all the flexibility required to meet practical conditions of varying speeds. For the alternating system a synchronous motor driving our three continuous-current generators will give us the four-wire system in any distant factory or town. For 500-volt street railway circuits a small motor generator plant for the slow speeds and a direct connection for full speeds will give us perfect results. For storage battery work we have the most perfect condition, as we can get any E.M.F. desired, with a corresponding speed while keeping the field separately excited.

Now that we have the rotary field at command, I think I may safely assert that the time is not far distant when we shall have transformers which will, without motion, convert an alternating current in the primary into a continuous in the secondary; and this seems to me to be the ideal system of the future—that is, one in which energy will be transmitted by alternating currents of constant E.M.F. transformed without motion into continuous currents for use at the translating devices and used where motors are concerned in conformity with the law of efficiency for motors: Vary the voltage as the speed desired; vary the amperes as the torque required.

MEMORIAL TO THE BOARD OF TRADE.

The signatures of all electrical engineers is desired to the memorial emanating from the London Chamber of Commerce:

To the Right Honourable Sir Michael Hicks-Beach, Bart, M.P.,
President of the Board of Trade, Whitehall, S.W.

Sir,—We, the undersigned, electrical engineers, electrical contractors, and others interested in the distribution of electrical energy, have the honour to address you on the subject of the Electric Lighting Acts of 1882 and 1888, and desire respectfully to submit to you the following observations on the subject of the use of overhead conductors in rural districts.

We are aware that in the case of the metropolis and of large towns your department has already decided that overhead conductors can only be permitted as a temporary arrangement, and that all permanent conductors must be laid underground. Whilst we are of opinion that that decision may even yet have to be reconsidered in the light of subsequent experience, we are anxious to make it perfectly clear that in this communication we have no wish to question the correctness of that decision, but we desire to emphasise the fact, that a marked distinction exists between undertakings which are to be carried out in the metropolis, in large cities or towns, and undertakings in small provincial towns or rural districts; and we beg leave to submit that however cogent may be the reasons which have led your department to decide against overhead conductors in large towns, such reasons do not apply with the same force in small towns or in rural districts. The objections to overhead conductors, based upon the inconvenience to traffic and the danger to life, are in the country far less serious, if not altogether absent, whilst on the other hand the advantages which such conductors afford are greater.

As regards the safety of the public—a consideration to which, as we are aware, your department is always bound to attach the utmost importance—we would submit that absolute prohibition of the use of overhead conductors is not necessarily consistent with increased security to the public. When overhead conductors are erected in conformity with well-considered regulations, and under proper supervision, the possibility of danger resulting from their use is so remote that it may be disregarded in view of the advantages gained. It may, in fact, be less than would be occasioned by the use of the underground mains.

With regard, on the other hand, to the advantages which are offered by overhead conductors, we would point out, that in the case of small towns and rural districts, the probable consumers of electric light will (at first, at any rate) be situated at relatively considerable distances apart, and consequently undertakers will have to use long stretches of conductors in order to reach such consumers, and this they can only afford to do by the use of overhead conductors. We are of opinion, therefore, that unless new discoveries should enormously reduce the cost of the work to an extent which at present we see no reason to anticipate, it will be a practical impossibility to introduce electric lighting in country districts except by means of overhead conductors; therefore the adoption of a fixed rule, that all conductors must be carried underground, would mean an absolute prohibition of electric lighting in such districts.

Another and almost equally important question arises out of the use of electricity for motive purposes. We are of opinion, that for the purposes of electric traction in rural districts, overhead conductors will be found to be the only mode on which long lines can be made commercially successful, and that a fixed rule which forbade their use throughout the United Kingdom would seriously retard the development of electrical motive power.

In view of these circumstances, we respectfully urge that your department should not lay down as a settled principle that no overhead conductors should be allowed, but that, in the rural districts at least, the circumstances of each particular case should be allowed to determine whether overhead work should or should not be sanctioned.

In conclusion, we beg leave to say that while we concur in the view that the use of overhead conductors should be regulated as stringently as the public interests may require, we think that the electrical engineering industry should not be hampered by their being unconditionally forbidden; and we submit that wherever in small provincial towns or rural districts the undertakers are able to satisfy your department that underground work would mean prohibitive expense, or for any other reasons would be impracticable, and that the objections to overhead conductors would be so slight that they might be disregarded, sanction should be given to the erection of overhead conductors, subject to such regulations and restrictions as experience may show to be necessary.

Botolph House, E.C., December, 1891.

CORRESPONDENCE.

"One man's word is no man's word
Justice needs that both be heard.'

OMNIBUS WANTED.

Sir,—Where is the electric omnibus? Now that the electric exhibition is about to open at the Crystal Palace it should be shown there, and be put on to run from the London, Brighton, and South Coast Railway low-level station to the Parade entrance of the Palace. It would be a help to visitors to the exhibition, and if can do that service it will do anywhere.—Yours, etc., W.

FINANCIAL ADVICE WANTED.

Sir,—I have taken five shares in the Electric Tramcar Syndicate. Would you oblige by giving your opinion on the tramcar?—Yours, etc., ——.

December 7th, 1891.

[We insert the above letter as a sample of what information we are supposed to give. Undoubtedly we do usually know something of financial matters connected with electrical companies, but it is impossible to advise on these matters through the columns of a technical journal. In this particular instance we are asked for an opinion as to the merits of a tramcar from an investor's point of view, whereas such an opinion, if given in our columns, should be from an engineer's point of view. Some directors obtain dividends for their shareholders with really nothing to work, others cannot obtain dividends with the best of apparatus in their hands. Such are the wonders of finance. Our correspondent has really gone too far before seeking advice. He should have sent before, not after taking shares, and then we might have been tempted to emulate *Punch*, who occasionally advises.—Ed. *E.E.*]

SHIPPEY BROS., LIMITED.—A DISCLAIMER.

Sir,—Our attention has been called to the announcement under the head of "City Notes," p. 552, in your journal of the 4th inst. We have to state that we have not purchased shares nor are we shareholders in the firm of Shippey Bros., Limited, to which reference is made, and we have to request you to contradict this statement in your first issue.—Yours, etc., Gwynne and Co.

Victoria Embankment, W.C., Dec. 9, 1891.

The Royal College of Surgeons, Dublin.—The president and council of the Royal College of Surgeons, at Dublin, have been making important alterations and additions of a most extensive character, which will make the schools the most perfect of their kind in the kingdom. A spacious new dissecting-room has been built, together with preparation-rooms and the necessary apartments requisite for anatomical study, and also a new physiological theatre and laboratory. It is further proposed to reconstruct the chemical laboratory and to erect pathological and bacteriological workrooms, and the council have recently decided to have the whole of these schools, together with the college itself, lighted electrically. They accordingly retained Messrs. Waller and Manville, 39, Victoria-street, London, S.W. (who, it will be recollected, are also acting as consulting engineers to the Dublin Corporation for the city central station), to advise them on the matter and supervise the work. Having invited tenders, the council accepted that of the Electrical Engineering Company of Ireland, it being the lowest and the most satisfactory.

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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OVERHEAD CONDUCTORS.

We have received from Mr. Crompton a copy of a memorial addressed to the President of the Board of Trade under the ægis of the London Chamber of Commerce. No doubt the memorial is clear and succinct, yet the exact purpose for which it is to be signed and presented is a little obscure; nevertheless, as there seems to be a desire to secure unanimity in the profession, everybody should sign it, especially as nowadays numbers carry weight. The prayer of the memorial, too, is one to which everybody can conscientiously subscribe blindfolded. It is simply, Please don't make a hard and fast rule, don't emulate the Medes and Persians, leave yourselves a little latitude; and your petitioners will ever pray, etc. No one objects to this, and it will be strange if the Board of Trade objects to it. In these latter days nothing is sacred, and while the Board of Trade permits Brown, Jones, and Robinson to form a company and fix up overhead wires for telephonic purposes, it cannot well have a hard and fast rule in other cases where absolute safety to life and property is assured. We had thought that Chelmsford luxuriated in overhead wires, that Carlow revelled in the same category, and that Leeds had an overhead tramway system. To the outsider it seemed the Board of Trade was not averse to considering each separate demand upon its merits, and had not actually committed itself to "nothing above the surface." If our contention is correct, and there is a desire at the Board of Trade to meet the legitimate demands of electrical engineers, why this memorial? The statements in the memorial are almost axiomatic. No one in the due possession of his senses would advocate an indiscriminate permission to electric light companies to put up overhead wires in London like the telephone wires are put up. There is no method nor system with the latter. The wires do not cross the streets in the least dangerous manner, but in a fashion which can only be described as higgledy-piggledy. If the memorialists have heard directly or indirectly that the precedence of Chelmsford, Carlow, Leeds, etc., will not be followed, there is grave cause for concerted action. A statement to that effect would do more to obtain signatures than the mere distribution of the text of a colourless memorial. We have no faith in these colourless non-controversial movements. The Board of Trade is a Government office controlled by a member of the Cabinet, and having said this it goes without further argument that whatever Government is in power care will be taken to try and make friends with the greatest number. If electrical engineers want overhead wires, they must agitate the districts in which they want such wires, get the consent and support of the local authorities, and when that is obtained they need fear no hard and fast rule of the Board of Trade. If public feeling is against the use of overhead wires, all the memorials electrical engineers can devise—be they vertebrate or invertebrate—will make no headway. A petition from a local authority to the Board of Trade will receive attention, and if it does not, a few questions put by some member in the House of Commons will soon bring out a reason why. This memorial notwithstanding, there is no combined action possible with electrical engineers and contractors. They are all ready metaphorically, and from a business point of view, to cut one another's throats. Each sees with his own eyes, and allows no good out of his own firm. The most despicable methods of trying to do business are rife. One firm cannot educate a district, but the moment the slightest hint is given, half-a-dozen other firms, more or less, rush in and try to oust the one in possession. Hints are thrown out here, doubts engendered there; Smith is no good, there is no one but Jones. If the authority decides for one system against another, no stone is left unturned to get the decision changed. Look, for example, at Glasgow—a city, one would think, quite capable of having its own affairs carried on in a business-like manner. But no. Careful reports are made and duly considered; experts are called in and give opinions. A decision is arrived at, only to bring about an attempt to change that decision. It is the officials and interested persons in rival firms that put up men to make statements calculated to unsettle the minds of those in authority. If the Electrical Section of the Chamber of Commerce finds it necessary to memorialise the Board of Trade, it would be wise to first have a general washing of its members. When a decision is given in any centre for any particular system, let rivals acquiesce in that decision and play fewer underhand games. When it is made public that a firm has been nursing and educating a district, let rivals keep away, and not rush to take an underhand advantage. Let the section combine to memorialise the local authorities and gain their support, then will be a nearer approach to the millennium of business methods than at present holds. We might also suggest that in some cases a determination to do good work when work was obtained would be more likely to attract public approval to the wishes of electrical engineers than is the case while electrical plumbing is rampant.

PROF. ARMSTRONG AND ELECTRICIANS.

No doubt it is beneficial for a friend to just open your door, take a couple of steps into the hall, and commence indiscriminate criticism as to the build and management of your house generally. If he is an expert it is wonderful what good conclusions he can derive from a few surroundings. This is what Prof. Armstrong undertook to do at the discussion on Mr. Robertson's paper at the Society of Arts last week. We are told that hitherto reversible batteries had been studied only by electricians, but now chemists were going to investigate the subject we should soon see what we should see. We may be allowed to differ with Prof. Armstrong as to the benefits of a change of name from "secondary" to "reversible" battery. Common-sense people do not finesse about names, and for all practical purposes the name "secondary" appeals to the simple mind more forcibly than "reversible." The "current"—and that is what the simple user looks for—is due not to the first action, but to the second action, which is admittedly a reverse of the first. The user only sees a current put in and a current coming out. The one he uses is the second—hence the popular name. With regard to the chemical action, we were under the impression that chemists had fairly studied the internal economy of secondary batteries; but that every investigator differed somewhat from every other as regards the minuter chemical actions, though not in the broader actions. As a matter of fact, we incline to the opinion that both chemists and electricians have attempted to tackle the problem of secondary batteries, and discredit for what has been done or not done ought not to be laid at the foot of either party. When Prof. Armstrong goes on to say that the chemical knowledge necessary for the due investigation of the chemistry of secondary batteries is of a high order, and that the pay offered should be commensurate to the knowledge required, we are at one with him. We are also inclined to admit that the Planté form of cell is the most perfect, as was maintained by Prof. S. Thompson and others years ago, but the most perfect cell to the scientific investigator may not be the best commercial form, and it is the best commercial cell the electrical engineer wants. His business is to make money, and he will trouble himself very little as to the type of cell, be it Planté or pasted, provided he obtains what he wants. An examination of the various cells at present before the public will tend to show that in each case the result is a compromise. In almost every direction the designer knows of something better, but good reasons are to be found for the use of the cell as put on the market. Mechanical, chemical, electrical, and commercial requirements have to be met, making it by no means an easy task to solve the problem of what constitutes the best form of cell to use for any particular purpose.

WORK IN THE COLONIES.

Elsewhere we give an abstract of a lecture delivered in Sydney by Prof. Threlfall. It is often asked why this or that is done, and Prof. Threlfall, going out of the ordinary groove of lectures, proceeds to give reasons for the plans proposed at Sydney. Many of the reasons advanced are as powerful to decide plans for other places at home as well as in the Colonies, and English constructors who hope to supply plant for colonial working should carefully study these reasons. It will be seen that Prof. Threlfall looks upon arc lighting—that is, series lighting—as the most simple problem in electrical engineering. The difficulties arise in general lighting or incandescent lighting. This great question of distribution has never been properly attacked by practical men, but Prof. G. Forbes is announced to lecture at the Society of Arts on the subject, and our readers will be glad to know that Mr. Hamilton Kilgour has for many months past been sedulously engaged in preparing a monograph for us on the subject. Mr. Kilgour has the distinct advantage of a sound mathematical training subordinated to a considerable practical experience. It is to be hoped, therefore, that at no very distant period a mass of correct information will be attainable which will assist electrical engineers in preparing their plans for central station work.

ON THE SPECIFICATION OF INSULATED CONDUCTORS FOR ELECTRIC LIGHTING AND OTHER PURPOSES.*

BY W. H. PREECE, F.R.S., PAST-PRESIDENT.

It cannot be said that we have hitherto been happy in our mode of specifying the insulating properties of electric light cables and conductors. Standards of quality and modes of classification differ with every manufacturer. The practice of the submarine cable engineer has been continued by the electric light engineer, and cables are specified to give so many megohms per mile, irrespective of their dimensions or of the purpose to which they are to be applied, while efforts are rarely, if ever, made to verify the figures so prominently given in published tables. If tests were made, it would be found that if the results were true for one sized conductor, they would be absolutely untrue for another. In a submarine cable, or in insulated wires for underground work, telegraphic or telephonic, the size of the conductor and the thickness of insulating coating remains constant, so that it is perfectly permissible to specify that the insulation resistance shall be x megohms per mile; but in electric light leads the diameters vary in every part of a building. A continuous mile length is rarely or never used except in mains and feeders, and the same mode of specifying is meaningless. Moreover, it is wrong, for if a conductor of 1 mm. diameter gave an insulation resistance of 2,000 megohms per mile when covered with an insulator 1 mm. thick, a conductor of 10 mm. diameter covered to the same thickness would give only 332 megohms per mile, yet its efficiency would be the same; while if it were constructed to give uniformly 2,000 megohms per mile, it would be absurdly constructed and wastefully paid for.

In designing an electric light lead we have to regard the insulating quality of the material to be used, and the potential differences it has to resist. Its mechanical merits we will neglect for the present. The quality of the material can be defined without reference to its form, and if it be, as it ought to be, of a uniform and consistent material, we want to know simply its specific insulation or its resistance to the passage of currents through it when subjected to potential differences.

SPECIFIC RESISTANCE.

The specific resistance, ρ, of conductors is thoroughly well known. The standard of reference is the resistance of a centimetre cube of some imaginary metal whose resistance is one C.G.S. unit of resistance at 0deg. C.—1,000,000,000 (10^9) cm. of this imaginary metal 1 cm.^{2} section gave an ohm.

The following table shows the specific resistance of various metals, together with their temperature coefficients.

Divide 10^9 cm. by ρ, and we obtain in any metal the length in cm. of 1 cm.^{2} sectional area giving 1 ohm. Thus $\frac{10^9}{1,580} = 632,911$ cm. of soft copper of that section, and this divided by 30·48 = 20,764·8ft., or 6,921·6 yards, which give one ohm.

Again, $\frac{10^9}{94,070} = 10,630$ cm. of mercury of 1 cm.^{2} section, or 106·3 cm. of 1 mm.^{2} give one ohm.

This table also implies that if we take a length of 10^9 cm. of any metal of 1 cm.^{2} section the number, ρ, indicates the resistance of that length in ohms. Thus 10^9 cm. of soft copper of that section gives 1,580 ohms.

	Specific resistance.	Temperature coefficient per 1 deg. C.
Silver	1,488	·00377
Copper (soft)	1,580	·00388
„ (hard)	1,616	·00388
Gold	2,036	·00388
Aluminium	2,881	·0039
Zinc	5,566	·00365
Platinum	8,957	·0034
Iron	9,611	·0048
Nickel	12,320	—
Tin	13,070	·00365
Lead	19,420	·00387
German silver	20,710	·00044
Platinum-silver	24,120	·00031
Platinoid	32,907	·00022
Nickel-steel	78,080	·00093
Mercury	94,070	·00086

Conductivity in submarine cables (of the Post Office standard type) is specified as follows: "Each conductor shall be formed of a strand of seven copper wires, all of equal diameter, shall weigh 107lb. per nautical mile, and shall at a temperature of 75deg. F. have a resistance not higher than 11·65 ohms or lower than 11·18 ohms per nautical mile.

The limits of resistance are defined in order to maintain the weight of the copper of the coils within a proper margin, and to secure the proper proportion between the metal and the dielectric. Improvement has recently taken place in the purity of the copper manufactured; the density is greater, and as a result we obtain coils which with our present mode of testing give a better result than that of Matthiessen's standard of pure copper. Coils giving 101 per cent. of pure copper are frequent, and 102 per cent. not uncommon. The manufacturers are prepared to supply pure copper; we therefore intend to abolish the percentage clause, and to abandon specifying anything but pure copper. But we must determine its specific gravity, for it appears clear that the high conductivity is due to greater density, and there is no reason to doubt the accuracy of Matthiessen's determination of the specific resistance of pure copper at a density of 8 90.

SPECIFIC INSULATION.

The specific resistance of insulating materials is not so well known as that of conductors, and is very variable. Clark and Sabine (1871) adopted as a standard the resistance of a cube-knot of the insulator at 75deg. F. (24·2deg. C.). But this standard never came into use, though it was tacitly admitted in all calculations derived from cylindrical cores using the knot as unit-length, and it was confined solely to submarine cables. The knot itself is an improper term, for a knot is a velocity, and not a length. The proper term is a nautical mile (2,029 yards) abbreviated into naut. Now, a knot is a "naut" per hour, and is a term confined to a class. Hence its use in any form as a general standard is out of the question. A cube-kilometre, or a cube-mile, would be a more convenient unit, but a cube-quadrant (10^9 cm.)^3 is in harmony with our C.G.S. system of units now universally accepted. The *specific insulation* of any insulating material is given by the formula,

$$\sigma = \frac{\rho\, l\, 2\, \pi}{\log_\epsilon \frac{D}{d}},$$

where ρ is the specific resistance in C.G.S. units of the dielectric of a cable whose length is l cms., and whose insulating sheathing has inner and outer diameter of d and D respectively (D and d being in any units). The specific resistance in the C.G.S. system being that of a cubic centimetre of the material, the dimension of such a unit gives an excessive numerical value: it reads as high as 10^{25}, C.G.S. unit—a figure beyond our comprehension. A more practical dimension is the resistance of a cube whose side is 1,000,000,000 (10^9) centimetres taken in megohms.

Since in this country it is usual (except in the case of submarine cables) to express insulation in megohms per statute mile, the specific insulation determined from this value will be given by the expression,

$$\sigma = \frac{R \times \cdot 9144 \times \frac{1,760}{10,000,000} \times 2\, \pi}{\log_\epsilon \frac{D}{d}};$$

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* Paper read before the Institution of Electrical Engineers on Thursday, December 10, 1891.

or, giving 2π its numerical value, and substituting common for natural logarithms, we get the expression,

$$\sigma = \frac{R \times 4{\cdot}39}{\log \frac{D}{d}} \div 10{,}000,^{*}$$

where R is the insulation resistance in megohms per statute mile.

(To be continued.)

SECONDARY BATTERIES.

BY G. H. ROBERTSON, F.C.S., ASSOC.INST.E.ENG.

At the end of his paper on the above subject, read before the Society of Arts, Mr. Robertson referred to the accompanying table (page 568) as having been compiled from the information received in response to circulars sent out.

The following further particulars are also given as to several of the accumulators noticed in the table: The Reynier cells are made up in boxes containing 16 couples. In the Tommasi multitubular accumulator the weight of the containing vessel is 6·6lb., and the volume of the acid is three-quarters of a gallon, but as the density is not given, the total weight of the cell cannot be calculated. In the Julien accumulator the 180 ampere-hours' capacity is at a discharge rate of 10 amperes. The electric lighting cells are in glass jars, the traction in covered rubber; electric lighting and traction. The Crompton-Howell accumulator is used both for electric lighting and traction, and also for electric welding. The Roberts battery is designed for both electric lighting and traction purposes. In the Tudor accumulator the plates weigh 112·2lb. The weight of the glass containing-vessel is 26·4lb., and the cells require 5·5 gallons of dilute sulphuric acid, but as the density of the acid is not given, the total weight cannot be calculated. The mean E.M.F. of discharge is taken at 1·9 volts, and the discharging limit is 1·85.

DISCUSSION.

Mr. James Swinburne said this was a very important paper, but he would not waste time in mere compliments upon its merits. Though Faure was credited with being the first to use the cells which bore his name, he would remind those interested that Kirchoff, an American, used a secondary battery of the same sort, with platinum plates, in which he electrolysed nitrate of lead and got a coating on both plates. He was not quite at one with Mr. Robertson as to the means used in "forming." He tried a number of experiments on this subject in 1883, but in all cases a solution was employed which would first dissolve the lead and then precipitate it; in fact, the idea was to follow the action in the manufacture of white lead. If you took a plain lead plate and eat into it with dilute sulphuric acid, it got coated with peroxide, which protected it. Planté kept reversing the action. This uncovered a new portion of the lead, and so by degrees eat into the body of the plate. He had tried nitric, sulphuric, and acetic acids, various chlorides, and a large number of other solutions; but the great trouble with nitric and other solutions was that traces of material were left in the cell which would eventually eat through the plate and destroy it. The least trace of chloride was fatal; it acted as a sort of carrier, and whenever it was used you failed to get a coherent coating. He got the best results with acetic and sulphuric acids in certain proportions. Acetate of lead was first formed; and as soon as the sulphuric acid got at it, it converted it into peroxide. He thought the idea of heating the plates was due to Brush, who published a very elaborate patent on the subject—a regular treatise—and, amongst other things, he mentioned heat to reduce carbonic oxide; and also that he got a very coherent spongy lead by the use of an alkaline solution. Such solutions did not give lead trees, but a closely adherent sponge. He also tried Dr. Schoop's silica jelly, but was not successful with it. It was very good at first, but soon changed, and was a jelly no longer. He examined some Schoop cells at the Frankfort Exhibition, which looked very like ordinary cells. There was no jelly in them, but there were several clots which, he was told, probably arose from something having fallen in. He also experimented with carbon; but the classical experiments with this substance were made by two Italians, whose names he forgot; and they found that carbon could never be used in any electrolyte from which oxygen was given off. It might be used in a strong solution of chloride, but even then it would waste away. He had not gone into the chemistry of it, but he knew that, in time, the carbon turned into a sort of black mud, which had no consistence whatever. He was the first, he believed, to recommend strong acid, and the reason was this: the action of a solution was due to the affinity of the radicle of the acid for the lead; if you had a dilute solution, the acid wanted of course to form a solution, and there was a certain heat formation; but if you used a strong solution you got a lighter E.M.F., because the acid had no longer the same inclination to mix with water, and therefore the inclination to form the lead salt was the stronger. He tried how far this could be carried, and at a certain point he found the spongy lead began to decompose the solution very quickly, and gave off bubbles of hydrogen, and that seemed to be the limiting point. Various theories had been started with regard to the pink solution. Mr. Crompton said it was due to gold; others said, if so, that was the first instance in which gold had come from a secondary battery. He found he could make the pink solution artificially by leaving peroxide of lead in commercial sulphuric acid, but in pure sulphuric acid it did not occur. The strength of the solution was also of importance; with very strong acid he got a much deeper colour. On testing it he found no trace of manganese, but a good deal of iron. At the same time Mr. Robertson was a skilled analyst, and on that point he was probably right.

Mr. Robertson said he had tried the corresponding iron salt, and found no absorption bands at all.

Mr. Swinburne said he only regretted that Mr. Robertson had not given more information about copper and other cells; people had been working at lead a great many years, and he believed the tendency now was to turn to copper as the cell of the future.

Mr. M. Immisch said he was a considerable user of accumulators and judging from the number of people who came to him with ideas, there must be something very fascinating in the subject. No end of people came to him with designs, some patented and some not; sometimes with actual apparatus, sometimes wholly imaginary; and his invariable answer was: Send me at your earliest convenience a dozen of your cells at your own price, and if only half what you promise is fulfilled, I can promise you every success. As this had been going on for some years, and though he had given dozens of orders, he had not yet got the cells; the inference was obvious. He himself had fallen under the spell, for, some three years ago, it occurred to him that the amount of active material in the cell was very small in proportion to the total weight, and he thought he would try to remedy that. He procured some solid peroxide plates, and at first the results were marvellous, but in a short time they were not so good, and ultimately he found they would not stand at all. The cells now made were very satisfactory in one way, if they were not so heavy, and if only manufacturers would give them more output in proportion to the weight they would do all that was required. In his experiments he found that the outside contact was at first very good, but it soon deteriorated, and at length there was none at all, so that he came to the conclusion that there was something more intimate, more solid, wanted between the conductor and the active material than he could get.

Mr. Bernard Drake said the D.P. cells were of the Planté type, but they had obtained not only the durability of that type, but the capacity which was supposed to belong only to those of the pasted type. The cells he first issued contained much greater capacity than any they had ever been able to make for the Electric Storage

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* A simple approximation to this formula has been worked out by Mr. H. R. Kempe as follows:

$$\log_\epsilon \frac{D}{d} = 2\left\{\frac{D-d}{D+d} + \tfrac{1}{3}\left(\frac{D-d}{D+d}\right)^3 + \tfrac{1}{5}\left(\frac{D-d}{D+d}\right)^5 + \dots\right.$$

Now, if D and d do not differ largely, we may neglect all the terms after the first without considerable error; so that the expression,

$$\frac{\rho\, l\, 2\pi}{\log_\epsilon \frac{D}{d}}$$

becomes

$$\frac{\rho\, l\, \pi}{\frac{D-d}{D+d}};$$

or, substituting thickness, t, of material, we get

$$\rho\, l\, \pi \,.\, \frac{d+t}{t}.$$

Inserting the numerical value of π, and making R the resistance per statute mile, we have

$$\sigma = R \times 5{\cdot}0559 \times \frac{d+t}{t} \div 10{,}000,$$

which may be written approximately, especially since we know that $\frac{d+t}{t}$ is actually rather too large.

$$\sigma = R \times 5{\cdot}05 \times \frac{d+t}{t} \div 10{,}000.$$

For general purposes the expression,

$$R \times 5 \times \frac{d+t}{t} \div 10{,}000,$$

or

$$\frac{R \times \frac{d+t}{t}}{2{,}000},$$

will give sufficiently correct results, being within 1 per cent. of accuracy in most cases. Thus, taking $D = {\cdot}5$, $d = {\cdot}314$, $R = 5{,}000$ (the actual results obtained with a rubber insulated wire), then $t = {\cdot}093$: by the exact formula we have,

$$\sigma = \frac{5{,}000 \times 4{\cdot}39}{\log {\cdot}5 - \log {\cdot}314} \div 10{,}000$$

$$= \frac{5{,}000 \times 4{\cdot}39}{\bar{1}{\cdot}6989700 - \bar{1}{\cdot}496029} \div 10{,}000 = 10{\cdot}865.$$

By the approximate formula we get,

$$\frac{5{,}000 \times \frac{{\cdot}314 + {\cdot}093}{{\cdot}093}}{2{,}000} = 10{\cdot}941$$

TABLE ACCOMPANYING MR. ROBERTSON'S PAPER ON SECONDARY BATTERIES.

Read Before the Society of Arts.

Accumulator.	Type.	Material of Cell. Lead plates, and H_2SO_4, or otherwise.	Capacity in ampere hours.	Capacity in watt-hours.	Charging current.	Max. discharging current.	No. of plates.		Thickness of plates in inches.		Total area of plates (sq. ft.).	Amperes per sq. ft. Total plate area. D'sch'ge.	Approximate external dimensions of cell.				Total weight of cell (lbs.).	Ampere-hours per lb. of total weight.	Watt-hours per lb. of total weight.	Efficiency (watt). Per cent.	By whom efficiency test was made.
							+	−	+	−			Length.	Breadth.	Height.	Height over all.					
													in.	in.	in.	in.					
Reynier ..	—	Lead and lead peroxide in sulphuric acid.	30	740	—	6 amps.	—	—	—	—	—	—	12	12	—	12	100	0·3	7·4	—	—
E.P.S.	1888 L	Lead grids pasted.	130	247	10 to 13	13	3	4	—	—	—	—	5¼	13¼	18¼	20½	74	1·7	3·3	—	—
	1890 K	H_2SO_4 ribbed lead plates pasted. H_2SO_4	—	—	15 to 25	25	3	4	—	—	—	—	5½	11½	13½	16½	81	—	—	—	—
Oerlikon ...	B	Hard lead grid plates made of red lead and litharge.	50	95	6	10	4	5	0·2	0·2	1·9	5	7·8	9·2	8·77	—	39·6	1·25	2·4	—	Prof. Kolrausch, Hanover. Dr. Coppe, Zurich
	E		260	494	30	48	5	6	0·2	0·2	8·9	5·4	9	14·4	16·4	—	156 2	1·6	3·1	—	
	F		160	304	18	25	5	6	0·2	0·2	5·6	4·4	9·2	11·7	12·5	—	96·8	1·6	3·1	—	
	D		70	133	9	9	8	9	0·1	0·1	3·8	2·3	5·5	6·8	8·6	—	26·4	2·6	5·0	—	
"D.P."	A	Pasted positives. Lead negatives dilute H_2SO_4	140	266	12	12	—	—	—	—	—	—	13½	8	12½	—	65	2·1	4	—	—
	H		725	1,377	66	66	—	—	—	—	—	—	13½	18	12½	—	240	3	5·7	—	—
Tommasi Multi-tubular.	—	Red lead and litharge in porous pots. Dilute sulphuric acid.	321	642	25 to 100 amperes.	18 to 30	9 tubes	9 rectangular.	9·75 by 2 by ⅜	9¾ by 2 by ⅜	—	—	6¾	6¾	10½	—	Total weight of electrodes, 47·7	Per lb. of electrode, 6·7	—	80	—
Julien	S. 17	Pasted plates	180	—	15	20	8	9	⅛th	⅛th	5·4	3·6	8	7	10	—	42	4·3	—	—	—
		Dilute sulphuric acid	180	—	16	20	8	9	⅛th	⅛th	5·4	3·6	7½	5¾	9	—	37½	4·8	—	—	—
Gadot..	1 A	Double grid containing pastilles made from oxides of lead. H_2SO_4.	28	53·2	3·1 amp.	52	2	3	—	—	—	—	7	3¾	—	13·6	17·6	1·6	3	—	—
	10 E		1063	2,019·7	116	193	11	12	—	—	—	—	21·6	20·4	—	26½	792	1·4	2·66	—	—
Crompton-Howell.	No. 11	Lead plates and H_2SO_4	220	440	28	85	5	6	¼	¼	11	20 at 3 or 10 at 10	8½	12½	12	14	115	1·9	3·8	85 Current efficiency, 93 to 95	Kennedy, Crompton, engineer, of Kensington and Knightsbridge Company.
	17		340	680	42	135	8	9	¼	¼	17		13½	12½	12	14	182	1·9	3·8		
	21		420	840	52	170	10	11	¼	¼	21		16½	12½	12	14	220	1·9	3·8		
	31		620	1,200	78	250	15	16	¼	¼	31		29	12½	12	14	460	1·4	2·8		
	61		1200	2,400	152	500	30	31	¼	¼	61		54½	12½	12	14	880	1·4	2·8		
Atlas	No. 1	Block composed of plates made of oxides and salts of lead. H_2SO_4.	150	$\left(\frac{2+1\cdot8}{2}\right)150$ 285	8	16 normal 10	10	10	0·4	0·4	—	—	7	6·29	12·57	13·75	Plates, 17·63 Acid, 6·6 Vessel, 2·2 to 8·8	9·6 per lb. of plates. 5·4 to 7 per lb. of total weight.	16·1 per lb. of plates. 8·6 to 10·9 per lb. of total weight.	—	—
Roberts......	Modified Faure twin plate.	Lead alloy. H_2SO_4 combined with an alkaline solution.	75	162	15	Practically unlimited.	2	3	9·32	9·32	18 9·12	4	7½	2½	10	12	20	3·75	8·01	87 to 93, according to rate of discharge.	G. M. S. Wilson, sec. Acc. Company, Toronto. Wm. Roberts, Elec. Acc. Company, Toronto.
			150	325	25		4	5	9·32	9·32	33 9·12	4	7½	5	10	12	38	3·95	8·55		
			250	545	35		4	5	9·32	9·32	63 9·12	4	9½	5	12	13½	70	3·55	7·71		
			450	990	50		8	9	9·32	9·32	108 9·12	4 (about)	9½	10	12	13½	110	4·09	9·00		
Legay	—	Plates made of lead wire rope formed by Planté's process.	194	364	20 amperes	200 amperes	4	5	⅓rd	⅓rd	75	—	9	9	9	11½	65 Plates 44.1	3·07	5·6	—	Laboratory of Société Internationale des Electriciens.
Tudor.........	VII.—A	Lead	240	456	18	24	—	—	1·3	1·3	—	—	—	—	—	—	112·2	2·1	—	—	—
	D	Lead peroxide in dilute sulphuric acid.	168	321	48	60	—	—	1·3	1·3	—	—	—	—	—	—	112·2	1·5	—	—	—

Company; he tested them carefully, and the capacity was very high, but they very soon deteriorated. On trying to produce them on a commercial scale, they met with a number of difficulties, and found that the rusting action which took place in the oxidising of the plates was very difficult to restrain or to equalise throughout the battery; but by a number of processes since introduced they had overcome this difficulty, and could now form plates by the thousand with a very small percentage of failures. The plates had been in use two years, and with properly-made cells they found no deterioration. It showed how history repeated itself, that after many years' experimenting with pasted plates they found it better to return to the old Planté cells. The rate of discharge was also very satisfactory; the conductor was simply a laminated strip, of a very early type, separated by the thin layers of peroxide formed on their surface, and the current would therefore be taken equally all through the plate, instead of taking it off at one corner, as was the case with peroxide plates alone, or plates of porous material. In the course of his experiments he had entirely confirmed the statement of Mr. Gorham in his paper at the British Association, that the great enemy was sulphate in excess, which produced buckling. If you could stop excessive sulphating, there would be no buckling; but if batteries were allowed to run out, and were left under conditions which would produce excessive sulphating, nothing would save them. This was common to all lead batteries, however made or treated. With regard to the specific gravity of the acid, his experience was that it should be varied according to the work required. For lighting a country house, where the cells would be left a fortnight or longer without changing, the specific gravity should be lower, and the voltage lower also, but the capacity of the cell should be greater. With such cells the risk of sulphating would be less. On the other hand, if the cells were to be used, as some had been at a large central station, discharged at about three times the ordinary rate allowed for plates of such a size, then the peroxide was liable to be reduced to the consistency of mud; under such conditions, better results were obtained with a higher strength of acid. With regard to copper cells, he had a good deal to do with Messrs. Elwell and Parker at the time the copper cells were brought over, and the return in proportion to the weight was certainly greater than from lead, but the invariable difficulty was that the zinc appeared to be soluble in the solution, and unless the discharge was taken pretty soon after the charge, the cell ran itself completely out in a single night. So far as he believed no one had been able to get over that difficulty, otherwise there would be a great future for copper cells.

Prof. H. E. Armstrong, F.R.S., said this paper marked a distinct epoch in the history of these reversible batteries, as Mr. Robertson very properly called them; the term secondary battery threw a sort of halo of mystery round the matter, which had distinctly retarted progress. This paper would serve to call attention to the great importance of studying the chemical changes going on in these cells, for up to now the matter had been almost entirely in the hands of electricians, and the chemical side had been to a great extent overlooked. The only thing noted was the interaction between sulphuric acid, the lead, and the peroxide. It was true that certain peroxides of hydrogen, and so on, were produced in minute quantity in the cell, but these were not taken much account of, whereas the outcome of the paper seemed to be that these substances which had been so neglected were really the disturbing agents, and that if the work of these cells was to go on with greater certainty and regularity under varying conditions, it would only be by making such alterations in the electrolyte, or otherwise, as would get rid of these perturbing elements. It was not a question of ordinary chemistry. This persulphuric acid to which attention had been called was a substance which the ordinary student of chemistry would probably have no knowledge of; and therefore the very highest chemical skill must be used if these problems were to be satisfactorily solved. During the last few years he had been more than once consulted as to recommending a chemist to those who were engaged in working at these cells, but on making enquiries he found as a rule that the pay offered was such as an ordinary laboratory office boy would scarcely accept. The idea was that someone was required who would make an occasional analysis of the peroxide, lead, sulphuric acid, or other materials employed; and it was the prevalence of that sort of notion which was answerable for so little progress being made. No chemist had set himself to the problem who had been able to thoroughly master the conditions, and study the question from all sides. If they had set to work in this country, when the cell was first introduced, as the Germans were doing now, the battery would years ago have been in a far better condition than it was now. From the chemist's point of view, he was much inclined to sympathise with what Mr. Immisch said; for if 5 per cent. of the weight of the cell was of any direct use, that was the very utmost, and it did seem strange, therefore, that it could not be very much lightened. It was also interesting to see how they were going back to the Planté form. Mr. Robertson and he had long been of opinion, from a theoretical point of view, that that was the right form, and that the pasted form was necessarily imperfect. The main reason for making the cell so heavy was a mechanical one; it was difficult to secure sufficient strength to prevent the plate from buckling unless such dimensions were employed.

Mr. Desmond FitzGerald, after complimenting Mr. Robertson on his paper, said he thought no essay on this subject was complete unless some reference was made to the fact that every form of the lead secondary battery was an essentially defective apparatus in one electro-chemical respect—that, in fact, a great blunder, though probably an inevitable one, was made in their construction, and that blunder was the bringing into contact with each other an electrolyte in two substances, so far apart in the electro-chemical scale as peroxide of lead—almost the most electrically negative element they knew—and lead, which was not far off zinc amongst positives. This at once suggested the question how was it, when all the elements for the production of a voltaic current of great intensity were provided, that the lead support which was in contact with the peroxide was not immediately oxidised and consumed. A partial answer had been given by Dr. Gladstone and Mr. Tribe, and a partial answer also by Messrs. Drake and Gorham. One phenomenon observed, whenever a piece of ordinary lead was brought into contact with the peroxide, was that the sulphating of the solid lead was merely superficial; and this protective superficial coating of sulphate of lead was the principal reason why this blunder, as he called it, was not attended with more destructive effects. Another cause was, that when you charged a lead support containing an active material which was convertible into peroxide of lead, the support was coated with an impervious layer of peroxide. If you charged a plate carefully, and set it by for some weeks, its capacity remained almost unaltered; but if it were partly discharged, and the peroxide layer were broken, the deterioration of the lead support was very rapid. He had an idea of his own as to the construction of a secondary couple which would be free from the defect he had pointed out, but it was too late to enter into it, and he would therefore defer a description of the lithanode to some other occasion.

Mr. Shippey wished to say that the Tommasi cell was not the invention of Dr. Tommasi, but of Dr. Woodward, an Englishman living in Toronto. He took it Paris to show a certain firm, and Dr. Tommasi, not knowing it was patented in France, copied it, and it was now known to the world by his name. He had already stated the facts in the *Electrician* and the *Electrical Review.* With regard to the cell No. 3, that was his traction cell, called in Paris the "Atlas." He made a double peroxide plate for the purpose of giving a very light cell, and they were now being made on a large scale, giving 200 ampere-hours, and the current could be taken off as required. Cells for lighting and for traction purposes ought to be constructed quite differently. His idea of a cell was a cylindrical one, such as was now being constructed at Messrs. Goolden's works. Dr. Woodward had arrived in London, and they would shortly be able to show a cell to the Society of Arts of from 3,000 to 4,000 ampere-hours; they were from 6ft. to 8ft. high for large central station work, and 3ft. or 4ft. diameter, perforated so that the acid went through the entire plate, and short-circuiting was almost impossible. He regretted that he had not been able to send Mr. Robertson particulars of these cells, but the patents were then pending, and he could not do so, but he should now be happy to give Mr. Robertson any information he required. There were two cells, a combination of the Gibson and the Woodward, which he honestly believed would do all that was required for traction purposes. The weight of the cylindrical cell would be about 35 per cent. less than the E.P.S. The negative plate was formed of lead, which was poured, when melted, over salt; then the salt was dissolved out, and then it was filled with a combination of various chemicals which he could not mention at present, which did not in any way affect it. The peroxide plate was of the Faure type, so arranged that it could not fall out; and he believed it would not buckle. The lead formed by the salt process was pure spongy lead, which could be cut into strips of any size required.

Mr. W. H. Patchell said he believed the Correns grid was the one seized by the German Government, and turned out of the Frankfort Exhibition, as it was thought to be an infringement of the General Post Office patent, but it was really Mr. Sellon's grid, and was now used for the negative in the General Post Office, but not the discharging plate. The Tudor plates were really horizontal, both positive and negative. In the General Post Office the positive plate was practically the same as the Tudor; but in the negative it was really the No. 4 grid, which gave a perfect negative, as far as he knew at present. As mentioned by Mr. King last winter, the negative plates, when some 18 months or two years old, began to show signs of shrinking, and with the ordinary form of square pellets they would fall away, but with the lattice grid, the more it shrank the tighter it became. Dr. Oliver Lodge had pointed out that there were three ways in which a cell could break down; it could fail from a defect in the positive, the negative, or the electrolyte; and he held Dr. Schoop's would break down from the latter. Any jelly or sawdust, or anything which prevented the diffusion of the electrolyte, would eventually break down the cell, because the strong acid concentrated on the plate and corroded it.

Mr. Robertson, in reply, said he had taken the Faure cell as the type of lead-pasted batteries, because the date of the introduction of this cell marked an epoch in the manufacture of reversible batteries. In the Kirchoff cell the plates were platinum, and therefore it was not altogether representative of lead cells. He had used improvements simply in the Patent Office meaning, and must not be understood as recommending any particular make. He had failed to get any more information about copper cells than he had given. Diminution of weight was of course the great point, and he hoped when they knew more about what happened in a cell, they would be able to construct them better; at present they were working a good deal in the dark. A very small portion of the weight was active material, and the difficulty had always been that you must have so much more material than you could use. Mr. Drake had confirmed his view that the strength of acid should depend on the work to be done. For a high rate of discharge, he believed in a high specific gravity, because, in working, you did not get such a large proportion of hydrogen dioxide formed, though on leaving it to stand at rest, the persulphuric acid would break up, probably, and form hydrodioxide. With dilute acid, roughly speaking, two-thirds of the acid was hydrogen dioxide, which was undoing the work you were doing in charging, and the same thing applied in discharging—you increased the rate at which the cell would run down. Increasing the strength of the acid increased the total quantity of active hydrogen formed, but the proportion of hydrogen dioxide in it decreased. Since the paper was written, he had had an opportunity of making experiments on some of Mr. Crompton's cells, which confirmed the views put forward in the paper from theoretical considerations. The density of the acid in the cells tested, when fully charged, was about 1,240, and they contained practically no hydrogen dioxide. The difficulty mentioned by Mr. FitzGerald had been felt for some time, but it was mainly a question of cost. He wished him every success with his lithanode cells. He was obliged to Dr. Armstrong for his appreciative criticism, and to Mr. Shippey for the information he had given.

The **Chairman** then proposed a vote of thanks to Mr. Robertson. He had had opportunities of watching the care, zeal, and determination with which the author had attacked the question, for, coming as he did with a strong recommendation from Prof. Armstrong, he had great pleasure in placing at his disposal all the resources of the Post Office. For years past they had been the most earnest advocates of reversible batteries for various purposes. They had used them for electric lighting, and were now using them to a great extent for the telegraphs. The whole system of telegraphy between this country and the Continent, including the telephone to Paris, was worked by these batteries, and he hoped gradually they would drive out of the field altogether the primary batteries. At present, however, they still had 30,000 of these, so that there was a big field for this very useful apparatus. Before many years were over, he felt sure that these 30,000 batteries would be reduced to one-tenth of the number, by the aid of secondary batteries, and with great economy. Mr. Robertson had not dealt with one very important point—viz., the chemico-mechanical cause of buckling, which was one of the great troubles which chemists ought to attack. He had, however, cleared up many difficult points, and they had certainly learned that whatever was produced by one man as his invention was immediately claimed by someone else. That showed how able men all over the world were directing their attention to this matter, and endeavouring to solve the mysteries of this instrument, which promised to revolutionise the practical application of electricity. Another point which might have been referred to was the practical use of sodium, of which he might give an instance. In May last it was reported to him that there were 28 E.P.S. L cells terribly sulphated, all covered with hard sulphate, and various attempts to get them into working order were made without success. Then a saturated solution of carbonate of soda was added, about half a pint to each cell, and at once the whole difficulty disappeared—the battery was got into order and had worked successfully ever since.

The vote of thanks was carried unanimously, and the meeting adjourned.

Mr. Robertson exhibited some fine crystals of persulphate of ammonium and potassium, prepared by Dr. Marshall in the chemical laboratory of Edinburgh University.

ELECTRIC LIGHTING OF CARDIFF.

The following is the report referred to in our issue of November 27 :

To the Lighting and Electrical Committee.

In pursuance of the resolution passed by the Lighting and Electrical Committee on the 21st day of July, 1891, your sub-committee (with the exception of the chairman, Mr. Councillor Vaughan), accompanied by the town clerk, the borough engineer, and Mr. W. H. Massey (the electrical engineer appointed by the Corporation), have to report that they visited London, Deptford, Bath, Havre, Paris, Brussels, Antwerp, Cologne, and Frankfort, with the object of obtaining the latest available information as to the progress of electric lighting, and the application of electricity to general industrial purposes.

The members of your sub-committee (and in this relation the term includes the officials associated therewith) have held numerous meetings in Cardiff, London, and elsewhere, at which they have had the advantage of discussing the question generally with some of the most distinguished electrical engineers and scientists engaged in the particular class of work to which the sub-committee have been desired to turn their attention.

Your sub-committee has everywhere been received with the greatest courtesy, and every disposition has been manifested to put them in possession of the fullest and most trustworthy information with regard to the development of electrical science.

At various points in the course of their travels upon the Continent, your sub-committee have found that deputations from other important cities and boroughs in this country, and also from Glasgow and Dublin, have been engaged on similar errands of enquiry and investigation.

Your sub-committee regret that they had not the opportunity of meeting and exchanging notes with any of the members of such deputations, especially as some of them were placed in a position to devote more time and money in extending the scope of their enquiries than your sub-committee felt warranted in doing.

It still remains for your sub-committee, before sending in their final report, to visit two or three large northern boroughs, the municipal authorities of which have already embarked in electrical enterprise, and from whose example Cardiff may learn possibly what to avoid as well as what to adopt in matters of detail.

The conclusions that your sub-committee have so far arrived at are that the promise of advantage to the community at large to be derived from the development and application of electricity in the future, is such that a prudent municipality will not allow the control of what must practically be a monopoly to pass into the hands of any private individual or company established for the purpose of profit. This is altogether apart from the still graver consideration of allowing any other body than the Corporation to come into the borough, armed with parliamentary powers, to tear up the streets and pavements of the Corporation.

In order to secure the control of the supply of electricity in the borough, it is incumbent on the Corporation, within two years of the granting of the provisional order (July 3, 1891), to put down works, and be prepared to supply electric current over a certain compulsory area, which may roughly be defined as embracing the portions lying between Westgate-street to the west, Working-street and the Hayes to the east, Castle-street and Queen-street to the north, and Custom House-street to the south. It has been estimated that mains can be laid and works established within the area itself, at a cost of about £30,000. Your sub-committee are, however, of opinion that whatever works are laid down should be designed not only to supply the electric current in the compulsory area, but also to form the nucleus of a supply station, capable of producing the whole of the electric current likely to be required throughout the borough during the term of the provisional order—viz., 42 years. In selecting a site for permanent works, it is of the highest importance that there should be proper communication by siding with a line of railway, for the sake of obtaining cheap coal (in respect of which Cardiff has immense advantages over London and other places), and also access to an unlimited supply of fresh water for condensing and other purposes. Such a site the sub-committee believe could be obtained in the neighbourhood of the Dumballs, adjoining the timber pond. This site is sufficiently near the compulsory area to enable the lighting of that area to be carried on at very little more cost than has already been estimated, and what is perhaps of equal importance, by means of electrical currents of only moderate pressures.

The members of the Corporation are doubtless aware of the difference between incandescent and arc lighting. The one—incandescent or glow lamp—is generally utilised for domestic purposes, and the other—the arc light—for street lighting and the illumination of large areas, such as railway stations, manufactories, and workshops. A different electrical pressure is generally used for each of these methods of lighting, what is called the low-tension current being employed for domestic purposes, and high tension for arc lighting, or for primary transmission. Without going into any technical details, it may be broadly stated that for economical reasons high-tension currents are necessary when it is required to distribute electricity to long distances or over large areas. It has already been demonstrated that this high-tension current can be transformed into low tension, and thus made available for incandescent lighting by a very simple appliance ; and your sub-committee are hopeful, from what they saw at Frankfort and from what they gathered in conversation with electrical engineers abroad, that this transformation can be accomplished in an economical manner. In that case it is obvious that the most practical method of lighting a scattered district like the borough of Cardiff would be by concentrating the machinery in one spot and distributing the electrical energy at a sufficiently high pressure over the given area, such current to be transformed as and where required. The objection to high-tension current consists principally in the danger to life and property which unprotected cables having such currents are likely to cause. By a proper system of insulation, and laying the cables underground, however, this can be entirely obviated, but the higher the tension the greater is the cost of insulating and providing safety appliances, and that is one reason why your sub-committee call special attention to the moderate pressures likely to be required for distribution in Cardiff.

Assuming that the Corporation decide to undertake the supply of electricity throughout the borough of Cardiff and to establish one principal station, the matters they would have to take into consideration in relation thereto would divide themselves into three main branches—(1) street lighting, (2) domestic lighting and shops, (3) supply of power.

STREET LIGHTING.

The best examples of street lighting that your sub-committee have inspected have consisted of a combination of arc lighting and gas, such as is seen at Brussels and Paris.

Your sub-committee are of opinion that a somewhat similar arrangement would solve the difficulty with regard to lighting the main streets of Cardiff, and that by this method such streets within the compulsory area could at a reasonable cost be lighted as brilliantly as the streets of any city or capital in Europe. Your sub-committee would, however, suggest that in order to accomplish this end it would be necessary that the electric lamps should only be run from dusk to midnight, at which hour they should be extinguished, and the ordinary gas lamps lighted.

Appended to the report is a statement by the borough engineer, showing exactly what the cost of lighting the streets of the compulsory area by gas is at the present moment, and what he estimates it would be in the manner suggested by the sub-committee. At Bath the arc lamps are so far apart that the effect which otherwise might be produced is seriously impaired, and such a method of street illumination would not commend itself to the ratepayers of the town of Cardiff. In Bath, even with what your sub-committee consider insufficient lighting by electricity, the cost to the local authorities has been increased by £1,600 per annum over what was formerly paid for gas. The best example of electric street lighting that your sub-committee have seen in England, is that carried out by the Brush Company, in Queen Victoria-street, London, where the arc lamps are placed at an average distance of nearly 45 yards apart. The yearly cost of each lamp is £26, and the charge for lighting this street is therefore at the rate of about £1,000 per mile per annum. In this case, as at Bath, the lamps are run from dusk to dawn.

DOMESTIC LIGHTING AND SHOPS.

As the result of very full enquiries, it appears at present that effective domestic lighting by incandescent lamps costs two and a half times as much as gas lighting—light for light, and hour for hour—and in some places the cost is even greater than this. Yet, notwithstanding, your sub-committee found that everywhere incandescent lighting was in great and increasing demand; and there are cogent reasons for this demand, for experience shows that in private houses electricity is not only a light of luxury, but also a light of health. As regards public buildings and business premises filled with expensive goods, economy is indirectly effected through the absolute freedom from noxious vapours and other destructive products of combustion; therefore, by the use of electric lighting in lieu of gas, the shopkeeper saves his goods, and the community its treasures and artistic decorations; and as against the extra proportionate cost of electric light is to be set the economy which can be effected by the much greater ease with which the light is turned on and off, so that the lamps themselves are not kept continuously burning, as in the case of gas. In private dwellings, this is of the greatest importance. For instance, when persons move from room to room, they instinctively operate the switches conveniently fixed near the doorways, and so use the lights only when, as, and where they are actually required. In the same way in a bedroom, lights need not be kept burning all night, because the room can be instantly illuminated by turning on a switch near the bed, and thus the consumption of electric current only occurs when absolutely necessary.

In London, some of the companies are being worked at a profit, whose business consists almost entirely of the supply of low-tension current for incandescent lighting. But it will be scarcely necessary for your sub-committee to say that the stations of these companies are situated in the heart of the wealthiest districts, where great mansions, clubs, and hotels are concentrated, and where the demand for electric lighting is, perhaps, ten times as much as it would be over an equal area in Cardiff. As an illustration, your sub-committee need only mention that some of the clubs in Pall-mall and neighbourhood spend over £1,000 a year upon the electric light.

SUPPLY OF POWER.

At Frankfort your sub-committee witnessed a most interesting example of the ease and economy with which motive power can be transmitted over long distances. At Lauffen, about 110 miles away, a waterfall operated dynamos from 100 h.p. to 300 h.p. The energy was transmitted through bare overhead wires carried on insulators to the electrical exhibition at Frankfort, where it was used for lighting, and also for driving motors for working pumps and other machinery. Your sub-committee were informed that the loss in transmission over this enormous distance was less than 10 per cent. They also saw numerous electric motors varying in power from tiny instruments, suitable for operating drills used by dental surgeons, up to motors for working large printing machines, and heavy tools used for industrial enterprises, and other works requiring considerable power. The result of your sub-committee's enquiries satisfied them that the electrical motors are being extensively used both on the Continent and in the United States of America, and that a considerable revenue is likely to be earned in the future by central stations supplying electricity for both light and power.

Your sub-committee also witnessed a most efficient, simple, and economical method of working tramways by electricity. In this instance the wires were carried overhead upon very simple and not inelegant supports, which, as far as your sub-committee could judge, would, if raised a little higher, afford no obstruction to traffic on country roads, and it is probable that, in some of the suburbs of Cardiff, a similar arrangement might with advantage be introduced, as is the case in Leeds, where just outside the town an electrical tramway, worked by overhead wires, is on the point of being opened with the sanction of the Board of Trade, at the request of the local authorities; but there are numerous reasons why no system of overhead wires, however economical and efficient, would be tolerated in the streets of a large town like Cardiff, and consequently some method of underground distribution will have to be devised. Your sub-committee have inspected the various systems in operation in London and on the Continent, but having regard to local conditions and to the special requirements of Cardiff, they have not yet seen anything which they could recommend the Corporation to adopt without modification. The borough engineer and Mr. Massey are going very thoroughly into this matter, and your sub-committee feel sure that something worthy of acceptance will be designed. The same remarks apply to more simple questions with regard to the precise kind of machinery and appliances to be adopted, and other details of the constructional portion of the works which they consider it would be best to adopt; but they hope to deal with these matters fully very soon after they have completed their enquiries.

Dated the 30th October, 1891. P. W. CAREY (chairman of sub-committee); LASCELLES CARR; J. L. WHEATLEY (town clerk); W. HARPUR (borough engineer); WM. H. MASSEY (electrical engineer appointed by the Corporation).

COUNTY BOROUGH OF CARDIFF—ELECTRIC LIGHTING.

Statement by borough engineer of present cost of lighting compulsory area by gas, and estimated cost of lighting same area, partly by electric lighting and partly by gas, as recommended by report of sub-committee, dated October 30, 1891.

The streets comprised in the compulsory area are at present lighted by means of the following lamps—viz.:

	£	s.	d.	£	s.	d.
Three 150-c.p. lamps at	12	10	0	37	10	0
One 150-c.p. ,, ,,	13	5	0	13	5	0
Seventy 100-c.p. ,, ,,	6	17	6	481	5	0
One 100-c.p. ,, ,,	7	10	0	7	10	0
Five 50-c.p. ,, ,,	6	0	0	30	0	0
Twenty-nine 16-c.p. ordinary street lamps	2	16	0	81	4	0
Total cost per annum				£650	14	0

To light the same streets partly by electricity and partly by gas, in the manner recommended by the sub committee, the borough engineer estimates the cost as follows:

	£	s.	d.	£	s.	d.
Sixty electric arc lamps, burning from sunset to midnight at	12	0	0	720	0	0
Eighty-two ordinary street lamps burning from midnight to dawn at present rate of prices, at	1	18	3	156	16	6
Twelve ordinary lamps burning from sunset to dawn as at present, at	2	16	0	33	12	0
Two 100-c.p. lamps burning as at present, at	6	17	6	13	15	0
One 150-c.p. lamp burning as at present		—		12	10	0
Two 50-c.p. lamps burning as at present, at	6	0	0	12	0	0
Estimated cost per annum				£948	13	6

W. HARPUR, Borough Engineer.

THE ELECTRIC LIGHTING OF SYDNEY.

LECTURE BY PROFESSOR THRELFALL.

The remarks on the subject of electric lighting of Sydney which I have the honour of making, are addressed neither to the expert electric engineer nor to the person who is wholly without information regarding electrical matters. Anyone at the age of 20, or over, who is without a rough idea of the *modus operandi* of a steam engine would be generally considered to be an ill-educated person, and exactly the same criticism is applicable to any member of the rising generation who is ignorant of the general principles of the machines by which electric currents are produced. I shall assume, therefore, that those who are kind enough to come here to listen to me are possessed of this element of education. If I were addressing you on some point in classical archæology you would probably consider that you ought to feel hurt and insulted if I prefaced my remarks by a *résumé* of Greek or Roman mythology; and I believe the time has now come when a man ought to feel still more insulted by the implication that he is ignorant of the principles of a dynamo machine or incandescent lamp. I say this after full consideration, and with the knowledge acquired after five years' experience of the public examinations, that general elementary information with regard to physical phenomena is at a lower ebb in this colony than in Queensland, or, I believe, in any other corner of the globe. The problem we have to face to-night has little to do with the generation of electric energy, or with its conversion into light in the lamps. We are solely concerned with a consideration of the best way of getting the electric energy generated in the stations up to the lamps. We may hope for some improvement in our engines, and an almost indefinite improvement in our lamps, but the dynamo of to-day is nearly a perfect machine, in which only a very insignificant amount of improvement is possible. The great problem is how to get the energy to the lamps most economically. Before I go on to describe in detail the arrangements which have been proposed to the City Council by Colonel Cracknell and myself, I must clear the way by some preliminary statement of the conditions to be fulfilled. At present we may say that there are only two classes of lamps in the market—the incandescent and arc lamp. The former is much less economical than the latter where great illumination is required, and consequently we have recommended that the streets marked red in the map before you be lighted by arc lamps. Now it so happens that lighting by arc lamps is the most simple and straightforward job the electrical engineer ever has to face, because it is not complicated by any great difficulty in designing an economical conductor. An average arc lamp takes about 10 amperes with 50 volts, or uses about 500 watts; or taking losses into account, the engines in an electric light station must develop nearly a horse-power per arc lamp. Such a lamp gives an illumination of rather less than 1,000 standard candles, and for some strange and obscure reason is often described as a 2,000-c.p. lamp. Now, the conductor necessary to transmit the current along a row of these lamps in series is not very big, for the current required is small, and may be reckoned at, say, £60 per mile. We propose to employ 431 arc lamps, which will require about 52½ miles of wire, costing about £3,150—a small sum compared with the rest of the proposed expenditure for street lighting, which is about £103,000. The only difficulty and considerable expense lies in providing proper conduits for the wires, but of this more presently. Our difficulties begin when we come to the installation for private lighting; for the street incandescent lamps are worked in a manner similar to the arc light, and cause no trouble. The trouble is this, that it is very difficult to arrange both the lamps and wires so that the brightness of the lamps to any given house shall be independent of the number of lamps which may happen to be in use at the time. It is by no means an easy matter to design a system so that the lamps all over a district shall be equally bright, whatever may be the number of lamps alight, or however their distribution may vary. We must add to this the necessity of providing for extension cheaply and speedily to meet new business, and this without interfering with the general conditions of supply, so that the problem becomes still more complicated. Happily, however, for us, the people of more progressive countries than ours have accumulated a considerable stock of experience, not so much as to what ought to be done as to what should be left undone. I have here a curious zigzag curve, which is called a load curve, and shows how the number of lamps varied during one day at a particular station in London. It does not profess to be an average curve; I took it merely because it was the first I happened to come across, and it will serve perfectly well. By following out the curve you will be able to form an idea of the habits of the people using the light. For instance, in this case the average time for breakfast is clearly 8; and hardly anybody gets up before 6, or goes to bed after 1. At 6 o'clock in the afternoon the shops are still open, and some people are having dinner. At 8 o'clock more shops are shut and people are finishing dinner, for the lights begin to go out very quickly, and continue to do so up to 1 o'clock. The first duty of an electrical engineer in designing the private lighting of a town is to attempt to construct a load diagram from the known habits of the people. He has, in fact, to conduct a statistical enquiry. I have spent a considerable time in wandering about the streets in the evening to see how the shops closed, and also in observing the relative number of people in the streets at different hours of the evening. I prophesy that the Sydney load curve will differ considerably from the curve marked in blue (which is, of course, a London December curve). My guess is embodied in the curve shown. Having settled on the most probable form of load curve, the next point in the investigation is to decide on the proper number of lamps for which provision should be made. At best the result will only be a guess, but we may guide ourselves to some extent by experience in other towns. The most important lesson we can learn is that the use of electric light is invariably rapidly increased after the means of supplying it have become known and relied on. Consequently we may be sure that so long as we do not attempt to force an outrageous number of lamps on the consumer, we are practically certain sooner or later to be able to dispose of all our electricity. The question therefore becomes simplified to the following: At what point in making provision for future requirements will the capitalised interest on fixed capital become equal to the extra outlay required in extension. For instance, suppose we have a district in which we discover by a canvass that 10,000 lamps will be immediately absorbed with a prospect, say, of 50,000 in five years' time. The question is, how far will it pay us to go in providing for the future from the very commencement? Ought we to provide for 20,000 or 30,000 lamps; or will it pay simply to provide for the immediate requirements and allow the future to look after itself? Now when we have to deal with underground modes of distribution the expense of pulling-up and laying down footways is pretty much the same, however often it has been done, and we may regard extension of existing conductors, whether in weight or length, as very nearly as expensive a process as the first laying, consequently I say wherever it is intended to employ an underground system it will be sound financial policy to lay mains of several times the capacity of the immediate demand. I consider that if the cables are continuously insulated it will pay to put them down for about three times the actual demand, but if they are of bare copper everything will depend on the details of the system. Now, by taking the number of houses in the various districts of Sydney, and making liberal use of the imagination, Colonel Cracknell and I have arrived at the conclusion that we might begin by making provision for the simultaneous supply of electricity to 10,000 lamps. This means that we may allow our customers to wire, say, 14,000 lamps, because experience shows that at the very most there are never more than 70 per cent. of lamps in use at once. This is particularly the case if current is charged for by meter, because people are careful to turn out the lamps they don't want, and so reap one of the chief benefits of electric lighting; whereas, if the lamps are paid for by assessment of so much per lamp per annum, people are wasteful under the impression that they are getting their money's worth. No idea could be more fallacious. If a thing is wasted it is gone, and somebody has to pay for it. The somebody is, of course, the consumer himself in the long run, both directly in that he has to pay a higher rate than he otherwise need; and indirectly in that the high price keeps other people out of the system. Supply by meter is, in fact, an essential feature of a good system; and the electric meter is not likely to follow the gas meter in gaining a proverbial faculty for duplicity. The public have this safeguard—that the electric meter can be tested in a few minutes at any time, and at a merely nominal expense, and that without disarranging any of the connections, or interfering with the fixtures in any way. Having decided on the number of lamps, and the load curve, it is now possible for us to consider the various systems of distribution that are in use at the present time. As I remarked before, the whole problem is the problem of distribution. How are we to get our electricity to the lamps without losing too much on the road? It will help us in considering this if we recollect that what we dislike losing is money, and not electricity. An American engineer once told me that he was economical by the dollar, but not by the coal, and our case is one of precisely the same kind. The principles of economical distribution may be said to be reducible to the following rules: The energy must be transmitted by as small a circuit as possible, and the mains must be of such a size that the loss of money by waste of electric energy is equal to the loss in interest on money expended in copper when the conduits are large enough to take more copper if necessary. Many tables have been given to help in such calculations, but my experience has been that the best way is to find by trial when the limit is reached, and for this Prof. Forbes's tables render invaluable assistance. The data for the solution of the problem are, however, unfortunately rather vague. We require to know the annual value of a horse-power, or, rather, the cost of production of a horsepower, for a year at the terminals of the dynamo. Here we can only be guided by experience. I have taken £13 as about the annual value of a horse-power, and then adjusted my calculations afterwards by the price of a horse-power thus provisionally worked out. It is, in fact, like a good many other problems, a case of successive approximation. Another datum is requisite in the interest and depreciation on the mains and cables. After considerable thought it turned out that the best value to allow lay at between 8 to 9 per cent. On these data the best sizes of all the wires required have been calculated. This, of course, involved the prescribing of an arbitrary distribution of lamps, and so the result of the calculation will to some extent depend on the agreement found between the way the lamps are absorbed in practice, and the way in which I have imagined them to be absorbed in making the calculation. The result of the calculation is that I know now pretty well how much every item of expenditure will be per lamp, and, consequently, I can modify the scheme in any required way, and still be able to give a very close estimate without any excessive calculation. One of the sample schemes I worked out was for 5,000 lamps in the district mentioned before—22, the northern end of the city, on a low-pressure continuous-current mode of distribution, and 5,000 on a high-pressure transformer system for the poorer part of the town, and none at all for the Haymarket end, which will, of course, be one of our best blocks. I hope and expect that a canvass will take place, for though, of course, it is not utterly to be depended on, it is a help, and may lead to the adoption of quite a different system. I will now briefly indicate the various systems we have at our disposal. They may be roughly divided into two classes. In one of them economy is arrived at by using large machines, and generally by keeping things simple. The other depends on getting over losses in transmission by using high-pressure currents and submitting to the loss incurred in transforming these currents to others of low pressure. In the first way we lose money in waste of energy in the mains and in interest on buried capital; and in the second we lose through the waste of energy in the transformer, whose "all-day" efficiency is by no means what we could desire. It is generally admitted that if a district is a favourable one, or if nearly every house will take the light, then the direct-current low-pressure system is the best; while if we have to carry out wires a long way for our customers, then the transformer plan is the best. Exactly where the point of equal advantage lies is still doubtful, but, as a pure matter of personal opinion, I am inclined, on the whole, at the present date, to give the greater favour to the low-pressure system. We know now what was not known a year ago, that the public will take to the electric light in a very favourable manner, and consequently, in designing a system, just as in designing mains and feeders, we are justified in looking ahead. Another great advantage of the low-pressure system is its great safety as far as life goes, the ease with which it can be combined with a partial system of storage, and its great future as a source of power. During the daytime a certain amount of machinery in a central station has always to be kept going to supply stray lights, and the cost of this daywork is only slightly increased by increasing the output. Interest and depreciation go on just the same whether the machinery is running or not, and consequently any current that can be sold in the daytime brings in an almost net profit. I have heard it argued that a lighting company should content itself with lighting, but this is on examination a mere *ipse dixit*, for what the company sells is electrical energy, and it has not, and ought not, to have any say as to what the consumer does with this energy once it has passed the meter and become his property. There is no doubt that any industry requiring intermittent power can obtain this with extraordinary convenience and economy by the use of electricity. Where the power is required continuously the advantages are not so obvious. I propose, therefore, to give a short explanation of some points in the distribution of electrical energy by means of the low-pressure system. Everything depends on the fact that for good lighting the lamps ought never to be supplied with a current of more than 2 per cent. above or below the normal pressure. Now, turning on lamps in obedience to a well-known law, is a process which reduces the pressure at the lamps. So that, for instance, if a person is burning one lamp only he may have a pressure of 102 volts, say; while, if he turns up 1,000 more lamps, the pressure may fall all round to 98 volts, and these limits should not be exceeded. If the pressure gets much above 102 volts the lamps soon wear out, though they give a fine light; and if the pressure falls much below, say, 98 volts, the light grows dim. Now electricians know that the variations of pressure in a system depend almost entirely on the size of the conducting wires, being great if the wires are small, and *vice versâ*. But we have already seen that for economy of mains a certain condition has to be fulfilled as to the size of the mains, and the economical condition is not necessarily satisfied at the same time as the condition enforced by the 4 per cent. allowable variation of pressure. In fact, we may design our mains economically and still not introduce too great a variation of pressure up to distances between 600 yards and 850 yards from the station, according to local circumstances. If we wish to go further than this the system becomes economical in itself, but not necessarily more economical than a transformer system. Again, on references to the load diagram, you will observe that the hours of maximum, or anything like maximum demand, are very few, and consequently we must recollect in all our arrangements that we must, by hook or by crook, provide plant, a great portion of which will not stand idle for the greatest part of the day. Probably the best solution of all the difficulties is to be found in the storage battery, which can be used—firstly, as an adjunct to the central station for the purpose of taking the extra load during, say, two hours per day, and so save moving plant; and, secondly, as a nucleus for districts outside the half-mile radius. In this second case the batteries can be charged at the nuclei or sub-stations by high-pressure currents from the main stations, and then can be discharged into the network. The battery is thus practically not so much a storage of power as a transformer from small currents of big pressure (involving economy of mains) to large currents of pressure suitable for lamps. Now for the drawbacks to this system. The loss of transformation may, I think, be taken at some 15 per cent. The depreciation on this part of the plant is also heavy—as much as 10 per cent.—and the first cost is large. The first person to use a system of this kind—charging at high and discharging at low pressure—was Mr. Crompton. I have on the board a diagram of another very interesting mode of using secondary batteries, at present in use by the Chelsea Company. This system is due to Mr. King, and consists partially of batteries used as transformers, partly as batteries used for storage, and partly by a very interesting dynamo-motor transformer, with an efficiency of 80 per cent. used to help during times of heavy load. Before leaving this system it is fair to say that I have recently received a letter from an English engineer, in whom I place great reliance, advising me to eschew batteries in every shape and form. The advantage of the use of three wires instead of two would take me too much into detail, and, therefore, I will merely show a diagram of connections. The three-wire system is the one on which my calculations have been based; but if we neglect the inconvenience of complexity, there may be an advantage in five, or even seven-wire systems. In fact, these systems save copper at the expense of increased regulating apparatus. I am not sure that economy of copper cannot be carried too far; for, after all, it is about the best asset in an electric installation. It has already been stated that we propose to light the poorer parts of the town by means of alternate currents and transformers. The same dynamos will light the street lamps on either the Westinghouse or Thomson-Houston systems, between which I find it hard to decide. One of the latest developments refers to the use of alternating currents for dense instead of scattered lighting. In this system the alternators are run parallel (a novel accomplishment) and the transformers are large, and are also in parallel—the alternating current being fed into the supply network from them. This system depends for its success on arrangements for putting the conductors in and out as required, and, I fancy, has a considerable future before it. It does not lend itself to power purposes, however, with any degree of readiness, and difficulties will arise with the feeders of the network if they have to grow to anything like three square inches of section. These difficulties may very well lead to necessary reconstruction of culverts, and it is an expensive operation. Another system is that used by one of the London companies. A very large station is erected on a convenient and cheap site, with good facilities for coal, water, etc. The current developed there is sent at enormous pressure through peculiar cables to a transformer station in the centre of the system of lamps, this station acting to the others as a central station. Let us turn to the question of whether electric light work should be done by the municipality or by the enterprise of private companies. The newspapers, I observe, have rather favoured the latter course; but, as a matter of fact, they are wrong in doing so, from the business point of view, as I can very easily show. The argument of those who think that electric lighting should not be undertaken by the municipality is, as far as I can make out, as follows: It rests on a dogma that a public body is not entitled to compete with private enterprise. To the ordinary citizen, however, it is, I take it, a matter of complete indifference who supplies the commodity in question, so long as it is supplied with the maximum efficiency and at the minimum cost. It is often stated that a public body cannot work a commercial scheme with the success of a private company; but that there is any real reason for this I deny, be the fact what it may. The central authority, in fact, controls a good many industries, some of which, at all events, such as the telegraphs and telephones, will compete in economy and efficiency with similar systems in any country in the world. Setting aside matters of sentiment, or conclusions arrived at by *a priori* reasoning, we have merely to enquire whether or not the public will be better served by leaving the electric light in the hands of the City Council. I understand that some people think that the public lighting should be undertaken by the Council, but not the private lighting. The fact is, however, that the cost of taking up the streets is so great that unless the same conduits can be used for the two systems, each is burdened with a large and unnecessary expense. Add to this that the stations would require to be doubled in number, and the expense of supervision also doubled, and you will perceive that the position that one body is to do the public and another the private lighting is financially out of the question. Whether a district be lighted by the Council or by a company, the whole of the lighting must be on one system, or an unnecessary waste is incurred. It has never, I think, been suggested that the Council should establish gas works simply for street lighting, or water works solely for street purposes, and the proposal to start an electric system merely for street lighting can only be based on a misapprehension of the facts of electrical engineering. We may assume, then, that financially we are compelled either to undertake all the lighting or none. Now, suppose it is decided to hand a given section of the town over to a private company, what measures will you take to ensure that the company does not secure a monopoly? In the first place you will limit its tenure. Result—a higher price for the commodity it sells. You will enforce it to keep its price below a certain maximum. Result—you will not reap any benefit from current inventions or new and improved systems of management. Suppose you grant two companies right over the same districts. Then, as before, unnecessary expense will be incurred, for each company will have its own mains, and, perhaps, different and inconvenient systems. In the end, of course, the consumer must pay for this. My argument is exactly this: If you take safeguards to prevent the creation of a monopoly, then as a business speculation the enterprise is not so good, and greater profits must be promised to tempt the investor. These profits must ultimately come out of the citizens' pockets. This, to my mind, amounts to a demonstration that the service can be more economically carried out by the Council than by private enterprise.

NOTTINGHAM.

ELECTRIC LIGHTING OF THE BOROUGH.

At the meeting of the Town Council on Monday, the question of lighting the town electrically was debated.

Alderman Sir John Turney introduced a report of a special committee, which recommended that the Corporation should undertake the lighting of Nottingham by electricity, and that the committee should be empowered to obtain specifications and estimates for the purpose. He said that it was something like four years since the committee was formed. They had considered the desirability of lighting up the greater part of the town with electricity. Many people had complained of their slowness, but he thought that the committee had gained considerable experience by the slowness with which they had proceeded. During the four years considerable improvement had been made in electric lighting all over the world, and they had the advantage of the experience of others. They, during that time, had also had the advantage or disadvantage of the experience and opinions of experts, which had been, as they might expect them to be, very conflicting. One advised one thing, another another, one high pressure, another low, one large, another small installations. It now, however, seemed to them that an attempt should be made to light a part of the borough with the electric light. The committee thought it wise and prudent that they should start on moderate lines, and they did not advise anything beyond that a moderate-sized installation should be put down to start with. He ought to have said that in the earlier consideration of the question of a provisional order they thought it advisable to hand over the work to electrical engineers, to a syndicate or company, but they had since made enquiries all over the country, and they had come to the conclusion that it was better to keep the lighting of the town in the hands of the Corporation. They now asked permission to light up a section, a central part of the town, at a cost of £25,000 or £30,000, to obtain specifications giving them the necessary details as to what they would require to light up a certain area which they would then bring to the Council for confirmation or otherwise. They did not intend to proceed without first consulting the Council, but they thought that they had arrived at a stage when, after deciding on a certain area, they might ask for tenders.

Alderman Sands had great pleasure in seconding. He said that while there were many differences of opinion, one of the gentlemen consulted, who could be thoroughly trusted, was in favour of small installations scattered over the town, and worked at a low pressure.

Mr. Lucas asked whether a short time ago the Council had not asked for tenders, and tenders had been sent in?

The **Town Clerk** said that was so, and the committee reported to the Council.

Mr. Lucas asked if the tenders had been before the Council?

The **Town Clerk** said that was not the usual procedure. The committee reported that they had come to the conclusion that the whole of the tenders were unsatisfactory, and the Council resolved to authorise the committee to employ such professional assistance as would enable them to report to the Council what action should be taken.

Mr. Lucas said that was an important question, which should be very carefully considered. It required more consideration than could be given to it that morning. They were asked to assent to the principle that the Corporation should itself undertake the electric lighting of the town, and to do so without discussion. Before they did so they should find out whether it was possible to induce private individuals to do so. He was informed that a company was formed, the directors of which were shrewd business men, and that they were willing to risk their money upon what, after all, was but a speculation. He thought that if they could find private individuals to risk their own money, they should not risk the money of the ratepayers in hazardous enterprises. The town clerk had told them that the committee had reported that all the tenders were unsatisfactory, but he submitted that the tenders should be open to every member of the Council to see for themselves, and that the matter should be adjourned until every member had an opportunity of seeing the tenders. He was told, and he spoke from authority, that one of the tenders for the lighting of the town was a most satisfactory one, and he knew that to his mind it was a most satisfactory one. He believed that they were willing to share all profits above 7 per cent. He thought that if that tender was open to the members of the Council they would hesitate a very long time before they would embark the ratepayers and venture their money in such an undertaking. He moved that the matter be adjourned to the next monthly meeting, and that the tenders which had been received should be open to the members of the Council.

Mr. Elborne seconded the amendment, in order that the feeling of members might be tested. He thought that as the Council had taken upon itself the whole of the responsibility of either adopting electricity for lighting the town, or not, they ought to have the advantage of looking at all the tenders, and passing individual judgment upon those that had been sent in, and see upon what terms companies would supply them. If it were true that there was a company ready to share all profits on capital after 7 per cent. had been realised, it seemed to him it would be better to let those people have the venture and for the Corporation to share their profits.

Mr. Pyatt said that whether the town should have the supply of electricity in its own hands or let the supply to a company scarcely required one moment's thought. Why should the Corporation have bought the gas and water concerns if they were going to allow someone else to pull up their streets and do as they liked in order to put down a supply of electricity? The course recommended, to allow some company to come into the town to supply the light, was most mistaken. The company saw they were going to make some profit or they would not risk their capital in the undertaking, and he contended that electric light ought to be supplied at the cheapest rate without any middleman's profit to come in. The electric lighting of the borough ought to be taken up with spirit now, because the time had come when the whole question should be dealt with in a broad manner. He did not believe in publicly opening tenders, because he thought it was not fair to bring those documents before the Council when there was no intention of acting upon them. A considerable number of people were anxiously anticipating the action of the Council in the matter. What was their position in regard to that committee? It was appointed on the understanding that some sort of powers should be given to them to enquire mainly as to the best means of preparing the way towards adopting the electric light. Was that committee now to be re-formed into a permanent committee to buy plant and erect machinery and sell the electric light? That was a most important question and one that ought to have consideration. The general feeling, he thought, was that one committee ought to have in hand the lighting of the town, and not two.

Mr. T. Hardy asked whether it was reasonable for them as representatives of the ratepayers to allow those "keen, shrewd, business men" of whom Mr. Lucas had spoken to go and take those profits away from the town, and whether they were doing the ratepayers a good turn by allowing them to come into the borough and experiment. In his opinion the period of experiment with electricity for public purposes had passed by. He thought, further, that the time had come when the Corporation of Nottingham should take a step in similar directions to those taken in other towns. He was of opinion they had derived all the profit they could hope to do from the experiments of other towns and various electrical companies, and now they ought to take a step forward and do something on their own account, and say to these "keen, shrewd, business men" that they did not want their interference in the town's affairs.

Mr. T. Bentley said that in his opinion Mr. Hardy had been thrashing a dead horse. He thought the clause inserted in the Act of Parliament distinctly stated—at least, if it did not, that was the feeling expressed by the town clerk at the time—that they themselves were going to get powers to deal with the question, so that if any private company came into the town the Corporation would be able to make terms with them. Every large town must now to a certain extent go with the times, and other large towns had not taken the question of electric lighting altogether in their hands. It was a question whether the Nottingham Corporation should take the matter entirely in their hands or dictate terms to those who wished to come in, but they had the experience of the past that it was best for them to deal with their own streets in the matter of putting down pipes, interfering with drains, and matters of that sort. It was a most important question, and one that ought to be thoroughly ventilated.

Mr. A. Brownsword seconded the adoption of the report, saying he did not see any use in delaying the matter at its present stage. When, later on, they got the report of the committee, with estimates and tenders, it would be time to discuss those details. He pointed out that there was a large amount of water power available in the vicinity of Nottingham that could be utilised for the purpose of generating the electric light. He would be glad to see it utilised, and, particularly, he had in view the weirs at Beeston and at Colwick, because it had been ascertained that distance did not interfere very greatly in the matter. Their forefathers in Nottingham had given the gas and water supplies of the borough over to different companies, with the result that the Corporation now had to pay £25,000 per annum more than was necessary for annuities on gas and water, and he was afraid that if they were to allow a private company to have the electric lighting, they might in the future be in pretty much the same box, or worse.

The amendment was then put, and supported only by **Mr. Lucas** and **Mr. Elborne**, and the original resolution was carried with but one dissentient—Mr. Lucas.

GLASGOW.

THE ELECTRIC LIGHT QUESTION.

At the meeting of the Glasgow Town Council on Dec. 3, the minutes of the Gas Committee and of the Sub-Committee on Electric Lighting were submitted, as follows:

"The sub-committee had a conference with Sir William Thomson on October 9, at which Sir William said he still adhered to the opinion that the low-tension continuous-current system of electric lighting was the most suitable for the area to be supplied by the Corporation. The sub-committee accordingly resolved to adhere to the minute of the Special Sub-Committee on Electric Lighting of April 27th. At a meeting held on 28th October, 'the sub-committee agreed to recommend that Prof. A. B. W. Kennedy, of London, be engaged to act as consulting electrical engineer to the Corporation, for the purpose of working out a complete scheme of mains for the compulsory area, and also for certain defined parts of the lighting area outside the compulsory district, including the arrangement of the machinery and plant inside the central station, the preparation of the necessary specifications, and the superintendence of the works while in progress.' From the minutes of the sub-committee on 18th November and 25th November it appeared that the offer of a site for a central station had been accepted, the ground being situated at the corner of Waterloo-street and Mains-street, and the price £8,000 over and above the feu-duty of £75. 7s. 4d. At another meeting 'there was submitted and read the report which has been obtained from Mr. James Muir, C.A., Glasgow, and Mr. James Muirhead, C.E., London, of the investigation which they made in regard to the business, machinery, and plant belonging to Messrs. Muir, Mavor, and Coulson, Limited. The sub-committee having carefully considered the report, resolved to recommend that it would not be advisable for the Corporation to purchase or acquire any part of the business, plant, or machinery belonging to the company upon the terms indicated by the company.' At a meeting of the sub-committee held on 9th October 'the sub-committee again had a conference with Sir William Thomson as to the best method of electric lighting to be adopted by the Corporation within the compulsory area described in their provisional order, and also within the various districts outside that area but within the limits of the municipality. After a lengthened and exhaustive conversation on the subject, in which all the members present took part, Sir William Thomson stated to the meeting that he still adhered to the opinion which he formerly expressed to the committee—viz., that the low-tension continuous-current system was, in the whole circumstances, the most suitable and economic method which could be adopted for the lighting, not only of the compulsory area, but also of the other portions of the city within which the Corporation might hereafter, from time to time, be called upon to supply electricity. The sub-committee accordingly, after deliberation, resolved to adhere to the report made to the Town Council in the minute of the Special Sub-Committee on Electric Lighting of date 27th April last.'"

After a stormy discussion, during which **Mr. Colquohoun** moved a direct negative to the effect that the resolution be rescinded, the original determination to employ the low-tension system was confirmed by 56 votes to 7. **Bailie Fleming** pertinently remarked that there was little use in employing a man like Sir William Thomson unless they followed his advice. Sir William Thomson's opinion was summed up in the words: "There are great possibilities in the high-tension system. But that was for the future; and as they were bound in Glasgow to supply electric light by the month of August next, they could not wait for this."

NEW COMPANIES REGISTERED.

Connelly Motor Company, Limited.—Registered by Wynne, Holme, and Wynne, 40, Chancery-lane, W.C., with a capital of £70,000 in £1 shares. Object: to carry into effect an agreement, particulars of which are not given, for the acquisition of patents and inventions relating to motors for the haulage of tramway cars, and to work and turn to account the same in any part of the world. The first subscribers are:

	Shares.
A. Lafone, J.P., M.P., Hanworth Park, Middlesex	1
E. Ellis, Summersbury, Shalford, Surrey	1
C. H Sprague, Malden, Massachusetts, U.S.A.	1
G. W. H. Ellis, Shalford, Surrey	1
G. F. Miller, Fall River, Massachusetts	1
R. Wynne, 40, Chancery-lane, W.C.	1

There shall not be less than three nor more than seven Directors. The first are A. Lafone, M.P., C. H. Sprague, E. Ellis, and G. M. Meller. Qualification, £500. Remuneration, before payment of any dividend, £1,000, with an additional 4 per cent. after payment of 15 per cent. dividend, 5 per cent. after 20 per cent. dividend, 6 per cent. after payment of 25 per cent., 7 per cent. after payment of 30 per cent., 8 per cent. after payment of 35 per cent., 9 per cent. after payment of 40 per cent., and 10 per cent. after payment of 45 per cent., the same to be divisible.

Henry Walker and Son, Limited.—Registered by T. W. Rossiter, 7, Ely-place, E.C., with a capital of £50,000 in £5 shares, 6,000 ordinary and 4,000 preference. The objects of the Company are to acquire the businesses of ironfounders and ironmongers hitherto carried on by Henry Walker and John George Walker, trading as Henry Walker and Son, at Gallowgate Iron Works, and at 55, Westgate-road, Newcastle-on-Tyne, and generally to carry on business as heating, ventilating, general and electrical engineers, plumbers and gasfitters, etc. The first subscribers are:

	Shares.
H. Walker, Jesmond-road, Newcastle-on-Tyne	1
J. G. Walker, 13, Haldane-terrace, Newcastle	1
J. C. Gover, Priorsdale, Clayton-road, Newcastle-on-Tyne	1
H. Benson, 41, Mosley-street, Newcastle-on-Tyne	1
J. McEwan, 29, Race-street, Newcastle-on-Tyne	1
J. G. Benson, 12, Grey-street, Newcastle-on-Tyne	1
J. J. Forster, Woodslea, Jesmond-road, Newcastle-on-Tyne	1

There shall not be less than three nor more than seven Directors. The first are H. Walker, J. G. Walker, J. J. Forster, and J. C. Gover—all of Newcastle. Qualification, £250. Remuneration: Managing Directors (H. Walker and J. G. Walker), £400 and £350 respectively; remuneration of ordinary Directors to be determined by the Company in general meeting.

"**Lightning,**" **Limited.**—Registered by Slaughter and May, 21, Great Winchester-street, E.C., with a capital of £3,000 in £1 shares. Object: to acquire real or personal property of every description, and to work, develop, and turn to account the same; also to establish, print, and publish newspapers, magazines, and books, and generally to carry on the business of printers and publishers in all its branches. There shall not be less than three nor more than nine Directors; the first are to be appointed by the signatories to the memorandum of association. Qualification, £100; remuneration, £100, with an additional sum of one-tenth of the net profits remaining after payment of 10 per cent. dividend.

CITY NOTES.

Great Northern Telegraph Company.—The receipts for the month of November were £22,400.

The Western Union Telegraph Company has declared a quarterly dividend of 1¼ per cent.

City and South London Railway.—The receipts for the week ending December 6 were £810, as against £806 for the week ending November 29. The total receipts for four weeks ending on the latter date were £3,201.

National Telephone Company.—The Directors have declared an interim dividend for the six months ending October 31 at the rate of 6 per cent. per annum, less income tax, on the first and second preference shares, and at the rate of 5 per cent. per annum, less income tax, on the ordinary shares.

The Commercial Cable Company announce the payment on January 2, 1892, of the usual quarterly dividend at the rate of 7 per cent. per annum. It is further announced that the drawing of bonds to take place this month for repayment in January will again be at the maximum of £120,000. The outstanding bonds will thereby be reduced to £200,000.

The Eastern Telegraph Company announce the payment on January 14 of interest at the rate of 3s. per share, less income tax, being 6 per cent. per annum on the preference shares for the quarter ending December 31; and the usual interim dividend of 2s. 6d. per share on the ordinary shares, tax free, in respect of profits for the quarter ending September 30.

Companies of the Month.—The following electrical companies have been registered during the past month:

Bicester Electricity Supply Company, Limited, £5 shares	£5,000
Connelly Motor Company, Limited, £1 shares	70,000
Electrical Finance Corporation, Limited, £5 shares	100,000
Globe Electric Company, Limited, £1 shares	10,000
Isle of Wight Electric Lighting Company, Limited, £1 shares	1,000
International Electric Subway Company, Limited, £1 shares	25,000
Johannesburg Lighting Company, Limited, £1 shares	150,000
New Motor Syndicate, Limited, £10 shares	5,000
National Telegraph Works Company, Limited, £5 and £1 shares	5,000
Patent Electromagnetic Clock Syndicate, Limited, £1 shares	25,000
Railway Electrical Fog Signal Syndicate, Limited, £1 shares	25,000

PROVISIONAL PATENTS, 1891.

November 30.

20807. **An automatic electric disc vote recording and counting machine.** Walter Hearn and William Frederick Lewis, 11, Queen Victoria-street, London.

20814. **Simultaneous telegraphy and telephony.** John Morgan Richards and Johnston Stephen, 46, Holborn-viaduct, London.

0825. **Improvements in the insulating or covering of or for electrical cables.** Henry Edmunds and George Edward Preece, 47, Lincoln's-inn-fields, London.

20827. **Improvements in electric lighting attachments for gas burners.** David James Quinn and Paul Walter Hoffmann, 55, Chancery-lane, London.

20830. **Improvements in electric safety lamps for mining and other purposes.** Ernst Bohm and Ernest Bailey, 57, Cheapside, London.

20837. **Extracting gold and silver from sea-water by electrolysis.** Charles Hyatt Woolf, Arthur Eugene Hayman, and Alexander Denon Rushton Jameson, 78, Fleet-street, London.

20840. **Improvements in armatures of dynamo-electric machines.** John Nebel, 28, Southampton-buildings, London. (Complete specification.)

20864. **A new or improved combined electro-medical apparatus coil and battery.** Thomas Clement Hodgkinson and Henry Thomas Tompsitt, 23, Southampton-buildings, London. (Complete specification.)

20865. **An improved electric railway system.** Alexander James Eli, 76, Chancery-lane, London. (James Slough Zerbe, United States.)

December 1.

20886. **Improvements in or connected with electric masthead and side lights for ships.** William Crammond Martin and John Hunter, 87, St. Vincent-street, Glasgow.

20900. **Improvements in arc electric lamps.** William Macpherson, 11, Furnival-street, London.

20913. **Improvements in electrically-propelled vehicles.** Mark Wesley Dewey, 45, Southampton-buildings, London. (Complete specification.)

20922. **Improvements in storage batteries or accumulators.** Carl Lütcke, 6, Lord-street, Liverpool.

20924. **Improvements in and relating to electric fire engines.** Mark Wesley Dewey, 45, Southampton-buildings, London. (Complete specification.)

20930. **Improvements in electrically-propelled vehicles.** Mark Wesley Dewey, 45, Southampton-buildings, London. (Complete specification.)

20933. **Improvements in and relating to electrically-propelled hose carts or carriages.** Mark Wesley Dewey, 45, Southampton-buildings, London. (Complete specification.)

20936. **Improvements in electric heating apparatus.** Mark Wesley Dewey, 45, Southampton-buildings, London. (Complete specification.)

20969. **Improvements in electrolytic tanks.** Trevenen James Holland, 6, Bream's-buildings, Chancery-lane, London.

20970. **Improvements in apparatus for measuring and registering electric currents.** James William Thomas Cadett, 33, Southampton-buildings, London.

20972. **Improvements in combined haulage and electric cables.** George J. May, 22, [illegible]-buildings, London.

L[illegible]

21018. [illegible] **in** [illegible] **on of electrically-con-** [illegible] Thomas Sch[illegible] Sun-

21028. **An improved gas or electric light appliance attached to a stud for the purpose of illuminating a dress shirt-front.** Walter Walton and Ernest Lester, 16, Knox-road, Clapham Junction, London.

21033. **Improvements in dynamo machines.** Lazarus Pyke and Edward Stephen Harris, 433, Strand, London.

21034. **Improvements in musical instruments operated by electricity.** Paris Eugene Singer, 6, Victoria-road, Kensington, London.

December 4.

21142. **Improvements in ceiling roses for electrical fittings.** Walter Poynter Adams, Springwell, Barnes, Surrey.

21143. **Improvements in electrical cut-outs.** Walter Poynter Adams, Springwell, Barnes, Surrey.

21154. **Improvements relating to electrical lampholders.** Charles Scott Snell and Woodhouse and Rawson United, Limited, 88, Queen Victoria-street, London.

21173. **Means and electrical apparatus for promoting the growth of bulbs and other plants.** Robert Henelade Courtenay, 6, Pennsbury-terrace, Wandsworth-road, Surrey.

21187. **Improvements in regulating steam engines working dynamo-electric machines and apparatus for that purpose.** Peter Valentine McMahon, 28, Southampton-buildings, London.

21207. **An improved electromotor.** Thomas Sturgeon, 8, Quality-court, London.

21211. **An improved electric call system and apparatus for use in connection therewith.** William Hamilton Blankeney, 45, Southampton-buildings, London.

21214. **Improvements in meters or recorders of electricity.** Alfred Julius Boult, 323, High Holborn, London. (Claude Lebois, ——.)

December 5.

21245. **Certain improvements in electric alarm and call clocks.** Joseph Louis Clerc, Jean Picard, and Iréné Rougeant, 64, Mark-lane, London.

21246. **Improvements in compound winding of groups of dynamos.** John Macintosh Mackay Munro, 154, St. Vincent-street, Glasgow.

21259. **Improvements connected with cash tills and means for electrically indicating each opening of the same as a check to the receipts.** Albert Samuel, Ernest Samuel, Thomas Furze, and Frank Simmonds, 166, Fleet-street, London.

21265. **A new or improved coin-freed device for operating electric circuits.** Henry Hutchins Brown, Anders Elliott, and Chetham-Strode, Limited, 4, Moorfields, London. (Complete specification.)

SPECIFICATIONS PUBLISHED.

1885.

9527. **Electric railways.** Handford. 8d. (Second edition.)

1890.

18554. **Electrical conductors.** Pierce. 8d.

19308. **Electrical distribution of power by alternating currents.** Swinburne. 8d.

20379. **Electric conduit.** Bayly. (Loth.) 8d.

1891.

258. **Electric arc lamps.** Gay and Hammond. 8d.

389. **Electricity meters.** Teague. 8d.

587. **Incandescent electric lamps.** Berlyn. 8d.

6773. **Signalling time, etc., by electricity.** Von Orth. 8d.

13553. **Electrically-heated ovens.** Mitchell. 6d.

16099. **Converting electrical energy of alternating currents.** Bradley and others. 8d.

17291. **Electric soldering irons.** Mitchell. 6d.

17406. **Arc electric lamps.** Todman and Angold. 6d.

17430. **Electric batteries.** Lamb. 8d

17454. **Electric conductors.** Threlfall. 6d.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Brush Co.	—	3¼
— Pref.	—	2¼
India Rubber, Gutta Percha & Telegraph Co.	10	19½
House-to-House	5	5
Metropolitan Electric Supply	—	10¼
London Electric Supply	5	1⅞
Swan United	3½	4½
St. James'	—	8⅞
National Telephone	5	4⅝
Electric Construction	10	5¼
Westminster Electric	—	6⅞
Liverpool Electric Supply	5	5½
	3	2⅝

NOTES.

Gerona.—The authorities of Gerona, Italy, have received tenders for a central electric installation.

Gelnhausen.—The works of the Electriciteits Maatschappij were burnt to the ground on December 2.

Worcester.—The date for sending in tenders for the electric lighting of Worcester is February 14 next.

Electric Railways in Switzerland.—An electric railway is to be installed between Valsthal and Langenthal.

Lille.—A scheme is being gone into at Lille for the supply of electricity produced by means of gas as motive power.

Telephone at Dunoon.—A telephone exchange is to be erected at Dunoon, with connections to Glasgow and other centres.

Berlin Electric Mains.—The Berlin Electricity Company have in the centre of Berlin alone a length of 20 miles of electric cables.

Marburg.—Herr L. Franz is intending to erect an electric transmission of power between St. Lorenz and Marburg, a distance of 18 miles.

Electricity in Paris.—On April 1st, 1890, there were 22,000 electric lamps in Paris. On 31st July this year the number had risen to 63,500.

City Guilds.—The prizes and certificates of the City and Guilds of London Institute were distributed at Salters' Hall on Monday, when the Lord Mayor delivered an address.

Lord Suffield, who underwent a second severe operation on Saturday, was last evening going on fairly well. He passed a very quiet night, and all the symptoms were favourable.

Tasmanian Tramways.—The tramways of the city of Hobart, Tasmania, which have recently been purchased by a London syndicate, are in future to be run by electricity.

Champs Elysee.—A company, we learn, is on the eve of commencing operations in Paris, by which at Easter the famous vista on the Champs Elysée to the Arc de Triomphe will be blazing with arc lights.

Galatz.—The authorities of Galatz, Roumania, announce an open competition for a concession for the lighting of the town of Galatz by either gas or electricity; tenders to be received by 1st February, 1892.

Electrolysis.—At the monthly meeting of the Edinburgh Mathematical Society last Friday, in the Edinburgh Institution, Prof. J. T. Morrison gave an account of the "Modern Theory of Electrolysis."

Huddersfield Engineer. — At a meeting of the Huddersfield County Borough Council on Wednesday, Mr. W. C. Mountain, of Newcastle-on-Tyne, was appointed electrical engineer at a salary of £200.

Bristol.—The suggestion is anxiously made in the local press that Bristol should be thoroughly up to date and use the three-phase currents for lighting, because three-phase motors have no need of commutators!

Attempted Suicide.—An unsuccessful attempt to commit suicide was made by a well-dressed man on the underground electric railway at Stockwell Station last week. Beyond a severe bruise the man was uninjured.

Great Eastern Railway.—The Great Eastern Railway have long lighted Liverpool-street Station, but a great deal of work is also done at Bishopsgate Station. When is this station going to be lighted? asks the *City Press.*

Central London Railway.—Preliminary borings for the Central London Electric Railway have been made, and reveal satisfactory conditions. The strata are easily workable, and no formidable water difficulties are apprehended.

Hucknall Huthwaite.—The meeting of the Local Board on Tuesday had to consider the supply of gas to the village. It was proposed to obtain electric light from a plant which was being laid down at the New Hucknall Colliery.

Eccles.—The Eccles Local Board have instructed the clerk to inform the Board of Trade that it was the intention of the local governing body to apply for an order to light the whole or a portion of the district with the electric light.

Canada.—A comparison of prices of arc lighting in the principal Canadian towns shows enormous differences in the prices of electric lighting. The prices range from 17dols. a year per lamp up to 108dols. in Toronto, and 146dols. in Montreal.

Underground Wires in Australia.—It is intended to place the telephone and telegraph wires throughout Victoria underground. The estimated cost of the work is about £78,000, and it is expected that it will be commenced at an early date.

Immisch Patents.—Mr. F. W. Hübel, of Messrs. Immisch and Co., is in America. Mr. Hübel will probably, says the *Electrical World*, endeavour to dispose of the American patents of Mr. Immisch, who himself is also expected shortly in the States.

Telephone Licenses.—The Postmaster-General has intimated to Mr. H. Erskine Muirhead, managing director Caledonian Telephone Company, Limited, Glasgow, that her Majesty's Government will now consider their application for a telephonic exchange license.

Continental Telegraph Lines.—Two new international telegraph lines affording direct communication between Vienna and Paris by way of Basle, and between Vienna and London by way of Bodenbach and Emden, were opened to the public last Saturday.

Frankfort.—The Frankfort Exhibition seems likely to have a permanent effect in that town, for it is announced that Herr Otto V. Miller and Baurath Lindley are completing a scheme for the installation of light and power transmission. A credit of 10,000 marks for preliminaries is voted.

Conversazione by Telephone.—The workmen of the National Telephone Company in Glasgow held their annual *conversazione* on Friday last in The Grand Hotel. In the course of the evening an address was delivered by Mr. Robert Gourlay, and by means of the telephone it was heard in the various newspaper offices.

Dutch Cables.—The home Government in Holland has decided upon laying a submarine cable between Olehleh and Labuan Deli, so as to bring Acheen in telegraphic communication with the Dutch Indies. The cost of laying the cable, which is to be 302 English miles long, is estimated at about 750,000 guilders.

Small Accumulators.—M. C. L. Weber has an article in *Electricité* which gives the details of construction advocated for a small battery of accumulators. Two coils of lead wire, one above the other in long thin glass tubes, is the arrangement shown. Such batteries would be used for laboratories or to charge electrometers.

Swiss Water Power.—The Cantonal Administration of Berne has granted a concession for the utilisation of a portion of the waters of the Aar, at Wynau, for the production of electric energy. The race will be 1,100 metres long, giving a flow of 80 cubic metres a second, with a fall of four metres, amounting to 3,000 h.p.

Callaly Castle.—Considerable extensions have been made to the above residence lately, including a fine museum and large stables. A complete electric light installation is also being installed throughout the main building, stables, and outhouses. The contract has been placed with Messrs. Drake and Gorham, of 66, Victoria-street, S.W.

Ennis.—The Ennis Town Commissioners invite specifications and tenders for the public and private lighting of the town of Ennis by electricity. Such specifications and proposals to be sent to the Town Clerk, Town Hall, Ennis, by Jan. 1. All expenses and costs incurred in the preparation of the said specifications and tenders to be borne by the parties sending in same.

Extraction of Foreign Bodies from the Eye.—Dr. Simeon Snell, who has given much attention to the use of the electromagnet in extracting foreign bodies from the retina, has a letter in the *Lancet* this week giving some particulars of his operations. Dr. Snell has put on record 77 cases in which the electromagnet has been used, and subsequent cases bring the number close to 100.

Telephonic Coast Communication.—The Mersey Docks and Harbour Board have accepted the offer of the National Telephone Company to establish telephonic communication by a metal loop wire between the Crosby Lighthouse and the Formby Boathouse, and the offer of the Postal Telegraph Department for the same between Waterloo coast guard station and Blundell Sands.

Greenock.—At the monthly meeting of the Greenock Police Board the clerk submitted correspondence with the Board of Trade on the subject of the Electric Lighting Order, 1883, and it was agreed to oppose any application which might be made by electric lighting companies for supply of electricity in town, but not meantime to apply for a provisional order under the new model order of the Board of Trade.

Personal.—The title of the firm started by Mr. C. E. Brown, late engineer to the Oerlikon Works, is Messrs. Brown, Boveri, and Co. The new works are at Baden, near Zurich, where we understand Mr. Brown has secured a large hall which is converted into a factory. M. Boveri is the financial partner in the new firm, which, with the talented engineer in charge, will doubtless meet with extended success.

Portable Electric Lamps.—Small portable hand lamps are now often seen in opticians' windows. The cost is not excessive, and they are becoming recognised as useful for domestic purposes. The *Optician*, while recommending such lamps, draws the attention of the makers to the fact that the greatest weakness is in the unprotected state of the small glass bulb, which is in many of these lamps open to risk of injury.

Train Lighting in Germany.—For the last month the night express between Frankfort and Berlin has been, by way of experiment, lighted with electric light. The current of the incandescent lamps is supplied by means of accumulators charged at the works in Gelnhausen. Two lamps are provided for each carriage, one of which can be turned off by the passengers, whilst the other can only be darkened with the curtain.

Overhead System in Brooklyn.—It is interesting, in the present state of electric traction in England, to learn that the Railroad Committee of the Brooklyn Board of Aldermen has received a deputation from the directors of the principal tram[illegible]anies in that town for perm[illegible] to introdu[illegible] trolley wires, and if a favourable decision is given, the new system will be in operation before next winter.

Dundee.—A meeting of the Dundee Gas Commission was held last Friday, when it was resolved to acquire a site in Ward-road for the purpose of erecting electric light works, provided the conditions in the missive of sale could be satisfactorily adjusted. A counter proposal that the Commission ask the Town Council to expose the old cattle market site was defeated. Mr. Urquhart, the engineer, attended, and gave explanations in regard to the proposal.

Cardiff.—At a special meeting of the Cardiff Lighting and Electrical Committee, the report, already published, was discussed. It was mentioned that the order had only 18 months to run, and the plant would take six months to put down, and the arrangements and letting of contracts six months more. Mr. Massey attended and gave information as to cost. It was decided to defer the matter till the town clerk had obtained particulars from the other towns lighted.

Mr. Tesla's Experiments.—Prof. Crookes, the president of the Institution of Electrical Engineers, when moving the annual report last week, announced that Mr. Nikola Tesla is on his way to England, and had promised to lecture before the Institution in January next, and that the Council would spare no pains to ensure that the lecture should be thoroughly well experimentally illustrated. This meeting is likely, therefore, to prove one of the most noteworthy of the coming session.

Inverness.—At a meeting of the Inverness Police Commissioners on Monday, consideration of a proposal to make additions to the gas works at an estimated cost of £10,000, and a suggestion to borrow this amount, together with a sum for the proposed electric lighting of the town, was taken up. The Commissioners resolved to defer consideration of the recommendation until the report of the official engineers on the water facilities for the production of the electric light is received.

Theatrophone.—On Friday night last an exhibition was given by M. Szarvady at the Savoy Hotel of the "theatrophone"—a telephonic instrument by which the attendance of persons at an opera can be practically obtained without bodily presence. The trials were regarded as very successful. The Theatrophone Company have already installed a considerable number of these instruments at Paris, and their introduction as a refinement of civilisation in London seems to be contemplated.

Chess Match by Telephone.—A novel event in the shape of a chess match played by telephone took place between representatives of London and Liverpool last Saturday night, the competitors being engaged at the City Hall, Eberle-street, on the one hand, and at the British Chess Club, Covent Garden, on the other. Two games had been arranged. The first was won by the Liverpool, but the second was abandoned after 60 moves. Mr. George Newnes, M.P., was one of the London players.

Efficient Motors.—Mr. H. Ward Leonard, whose article on economical transmission of power was given by us last week, is making arrangements to apply his inventions and devices on a considerable scale in New York. The patents have been granted, and contain some sweeping claims. In principle the method consists in supplying volts proportional to the desired speed, and amperes proportional to the desired torque. Combinations of alternate and direct current for motor work are also employed.

Sims-Edison Torpedo.—A trial of the Sims-Edison dirigible torpedo has been made on the Tyne, at Newcastle, before Sir William G. Armstrong. This trial was made to demonstrate the practicability of launching a dirigible torpedo from a ship in motion, and notwithstanding very bad weather, rain, and fog, it seemed eminently satisfactory. Notwithstanding various manœuvres, there was no fouling of the cables in any way. An exhibition is to be given very shortly before the Lords of the Admiralty at Stokes Bay.

Mansion House.—The work of installation of the electric light into the Mansion House, which has occupied the last five weeks, was finally completed on Wednesday. The General Purposes Committee of the Corporation have visited the building, and expressed their satisfaction with the way in which the operations had been conducted. This is the first time in which the Lord Mayor's official residence has been entirely lighted by electricity, and the various reception and State apartments appear to great advantage. The Planet Electric Lighting Company carried out the tender for the work.

Cut-Glass Fittings.—It has been often the complaint that English buyers were too fond of patronising German goods, and that orders which ought to have been placed in England go to Germany. That this may be so too often, especially with the cheaper class of goods, is admitted. But we hear of a satisfactory case on the other side which demands recognition. The fashion is now apparent in Berlin in rich and artistic circles for English electric fittings, especially the beautiful cut glass of Messrs. Osler's, and many thousands of pounds worth have been recently shipped to the German capital.

Mining Lamps.—We are glad to learn that the outlook for electric mining lamps is exceptionally good at this moment. The Mining and General Electric Lamp Company have done a wise thing in handing a few dozen lamps to be thoroughly tested in the Northern collieries, and where their behaviour in the rough and tumble work of the mines is very satisfactory. We believe that orders for several hundreds of these steel-cased lithanode battery lamps is practically assured. It is time the matter took a practical shape, for the demand is not to be numbered by dozens of lamps, but by hundreds of thousands.

Telephoning at Sea.—The following note is from the obituary of the *Daily Chronicle*: "Mr. George W. Stuart, inventor of the sea telephone, died of heart disease at New York on December 9th, just after he had secured a promise of capital with a view to pushing his invention." We are not acquainted with the invention mentioned, nor assured of the possibilities of useful telephone communication between ships, to which it seems to refer. But it is certainly unfortunate that an enthusiastic inventor should die just at the moment when he is within sight of port. If there is anything in Mr. Stuart's invention, we hope it will not be left to subside without trial.

Croydon.—The attitude to be taken by the Croydon Town Council on the question of electric lighting is that of a waiting game. The Council were called upon to decide whether they would themselves apply their powers by erecting a central station, whether they would dispose of or transfer those powers to a company, or whether they would allow the matter to remain in abeyance to see what is being done in other places and what is likely to be the result of an application of the powers of which they are already in possession. The Council, acting on the recommendation of the General Purposes Committee, have resolved to adopt the third proposal.

E.P.S. Cells.—It is now nearly six months since the Electric Construction Company gave up the manufacture of accumulators, turning over the Millwall works to the reconstituted Electrical Power Storage Company. Mr. Frank King states that the output of cells is 50 per cent. greater than it has ever been before, and the work is still increasing. The future for secondary cells is assured. Although the monopoly has been fiercely assailed, the E.P.S. maintain the ground. The K type of cell gives, says Mr. King, four times the output of the old L type, 16 amperes per plate instead of four amperes. At the same time the discount in prices is greater, and the price will be again probably reduced if the sales are sufficient.

Exhibitions.—The gathering importance of the Crystal Palace Exhibition is indicated by the remarks made at the meeting of the Cardiff County Council on Monday, where, on the Electric Lighting Committee's minutes coming up for confirmation, Alderman Sanders asked if the Electric Lighting Committee had received any intimation of the exhibition to be held at the Crystal Palace in January; he believed more information as to the newest developments of electric light would be got there than anywhere else. Alderman Carey answered that this had not escaped attention. The Corporation expert, Mr. W. H. Massey, was a member of the executive of the exhibition, and the Council would obtain all the information possible.

Dartmouth.—At a meeting of the Dartmouth Corporation, last week, attention was called to a clause in an agreement with the gas company prohibiting the works being used for any other purpose than that of the manufacture of gas, and also prohibiting any nuisance. The gas company desired the omission of the clause in view of the possible adoption of the electric light in preference to gas as an illuminant. Mr. Councillor Atherton asked if this would give the company any preference over the Corporation in reference to lighting the town by electricity, and the town clerk said the sanction of the local authority was necessary before electricity could be adopted generally. The clause was omitted, except that portion relating to a nuisance.

Glasgow.—A correspondent of the *Glasgow Herald* points out that there is water power running to waste at West End Park, at the weir of Clayship Mills. There is another weir at the Great Western Bridge over the Kelvin, while the weir might be reconstructed on the Clyde above Albert Bridge. There is also the question of obtaining power from the more distant Falls of the Clyde. Mr. Rankin Kennedy, in reply to the above, writes to say he considers the water power in Glasgow too small, and thinks that the best source of power for the town would be the gas, which is only 2s. per 1,000ft. This in a gas engine would produce 400 16-c.p. lamps, which at 8d. a unit would produce 16s. at a cost for fuel of 2s. He suggested the alternating-current system as best.

London County Council.—At the last meeting of the London County Council, the Offices Committee reported that in connection with the extension of the electric light in the central offices, they had authorised the connection of the new electric lighting circuits with the mains of the two supply companies being put in hand at once; and that they had accepted the estimate of the London Electric Supply Company (£92) for low-tension mains from their Red Lion-yard station; and the estimate of Messrs. Mather and Platt for the Electric Supply Corporation (£81) subject to the cables used being of 600 megohms insulation resistance. The estimated cost of the work has been included in the specification for the installation work, the tenders for which were opened by the Council, and are given in our business notes. The course taken by the Council was approved.

Rhondda Valley.—An adjourned meeting of the promoters for the supply of the district from Treorky to Gelligaled with the electric light has been held at

Pentre, under the presidency of Mr. David Lloyd, Ystrad. The canvassers presented a most encouraging report, which clearly demonstrated that the question was taken up most enthusiastically by the general public. It was resolved to invite Mr. Williams, electrician, Ocean Collieries, to attend the next meeting, with a view to obtain further information, and to take steps to bring the whole question to a practical issue. Two gentlemen were appointed to make enquiries as to the legal aspect of the undertaking, and the probable cost of obtaining the necessary powers to form a company. The present charge for gas is 4s. 3d. per 1,000. Expectation is expressed of a speedy practical outcome of the movement.

Middlesbrough.—A report is to be presented by the Middlesbrough Electric Lighting Committee to the Town Council embodying information as to the action of local authorities from various sources. They applied to 97 local authorities; of these 27 were in the position of Middlesbrough, where the gas works belong to the Corporation, and the majority of these have either taken no steps at all, or have kept private firms away by applying for a provisional order which they have not put in force. The report will be put before a special meeting of the Town Council next month. There is a tendency to think the time is hardly ripe, and the "bitter experience of Barnet" is alluded to. When, however, it is remembered that at Barnet there were only 70 lamps of 30 c.p. in all, while many a good-sized private house has more than this installed, no very great inference must be drawn from the failure of this incandescent lighting for public streets. Perhaps the Middlesbrough councillors require fuller information on the latest developments of town lighting.

Plymouth.—At the meeting of the Plymouth Borough Council last week, a resolution by Mr. Kerswill was carried: "That it be referred to the Works Committee to consider and report to the Council upon the desirability or otherwise of obtaining powers for lighting the borough by electricity, and that they confer with the Water Committee as to whether water power could be made available for generating electricity." They had waited patiently, he said, for a private company to undertake the work of electric lighting, and the company having failed to do so, the Corporation had a favourable opportunity of taking action. The lighting of the town by electricity ought to be in the hands of the Corporation rather than of a company, and in his judgment their water supply should be used as a motive power. Mr. Square, in seconding, was convinced that the Plymouth Council could carry out a system of electric lighting more cheaply than almost any other corporation in the kingdom, because they had such abundant water power.

Electric Cart.—Amongst the public very few electric contrivances awaken such interest as self-propelled vehicles, such as omnibuses, tricycles, and carts. The electric tramcar, especially with overhead wire, seems to have a slight explanation of its movement, but a self-contained electric cart, running with ordinary wheels on the road, is a "marvel." Mr. Radcliffe Ward, who has made this branch of electrical engineering his speciality, has just completed an electric provision-cart, which we had the opportunity of inspecting last week. It is a handsome vehicle, giving no idea of clumsiness, with neat indiarubber-tyred wheels, and the gearing and motor completely hidden from sight. The only peculiarity is, of course, the absence of horses and shafts. The car was made for a well-known provision merchant in the north of London, but as the time of contract was exceeded, and it was countermanded (though, we believe, now eagerly sought again), it is not quite certain what will be done with it. Mr. Ward should certainly exhibit his cars and omnibuses at the Crystal Palace.

Nottingham.—The electric lighting question at Nottingham, which has been under consideration by a special committee during the last four years, has now been satisfactorily settled. They have consulted several experts, who, it was said, by the way, were all at variance; but now that the people of Nottingham had made up their minds to have the light it was the duty of the Council to supply it. The adoption of the report of the Electric Lighting Committee was moved at last week's meeting by Alderman Sir John Turney, permission being asked to make a start on moderate lines at a cost of £25,000 to £30,000. They had received tenders, but none of them had been accepted. They were not read, but the terms of one of them—the profits to be shared over 7 per cent.—were mentioned. The committee were in favour of small installations at low pressure at various parts of the town. The report was adopted with only two dissentients. During the discussion, Mr. Brownsford pointed out that they had a large amount of water power at disposal which he should be glad to see utilised.

Reckenzaun Accumulator.—For some time past Mr. Reckenzaun has been working at a new form of accumulator, of which much is likely to be heard in the future, especially in traction work—a field Mr. Reckenzaun has made his own. We inspected a specimen of the new Reckenzaun accumulator the other day, and although the matter is perhaps hardly ripe for full description of the process of manufacture, we may give an idea of the cell, which has been, we understand, under practical test for over 18 months. The cell is of the Planté type, and therefore quite clear of the E.P.S. patents. It is also charmingly simple, consisting simply of lead strip fastened together in a special way to allow of percolation of the acid, the lead strip having been previously oxidised in a highly ingenious manner on the surface. The plate can be bent or thrown about, and the aim of the inventor has evidently been to produce a plate which could be manufactured so easily and cheaply that replacement after the wear of a year or so would not preclude its use. This is tackling the subject on its practical side, and we certainly shall hope to hear more of this cell.

Electric Lighting in London.—Among the electric lighting schemes with which Parliament will be called upon to deal next session are proposals for the lighting by electricity on the part of the Vestry of St. Pancras, who ask for power to raise further money for the purpose of electric lighting, and to confirm the appropriation and user by the Vestry of the abandoned pneumatic tubes in Tottenham Court-road, Euston-road, and Drummond-street. The Vestry of Lambeth seek power to supply electricity within their parish, and to lay distributing mains, among other places, along the Lambeth-road, Kennington and Kennington Park roads, the Oval, Albert-embankment, South Lambeth-road, Stockwell-road, Clapham-road, Camberwell New-road, Brixton-road, Tulse-hill, Denmark-hill, and Norwood-road. The Vestries of St. Leonard, Shoreditch, St. John, Hampstead, the Whitechapel District Board of Works, the West Ham Corporation, the Urban Sanitary Authority for Sutton (Surrey), the Putney and Hammersmith Electric Light and Power Company, and the Hackney Electric Lighting Company are also the promoters of schemes for the supply of electricity for public and private purposes.

Cathode Frames.—With a view to improve the character of the deposited copper in the electrolytic refining of that metal by preventing the "treeing" of the copper at the corners and edges of the cathode plates, Mr. Alexander Watt has obtained a patent for the application of a frame of wood or other insulating material, which prevents the metallic deposit at the corners and edges of the plates, where crystalline growths of copper or "trees" usually form, and the metal consequently deposits in a more uniform condition, and on the flat surfaces only. The cathode frames may be made from any suitable wood, such as beech, for example, about 1in. by ¾in., cut into suitable lengths, and each part grooved to receive the copper plate. The several parts of the frame may be put together by rabbetting, or in any other convenient way, and held together by wooden pegs; if these pegs are allowed to project about an inch on each side they can be more readily withdrawn from the frame when the plates have to be removed. To prevent the frames from absorbing the solution, it is recommended to brush them over with a coating of varnish, a thin layer of white hard varnish being very suitable for the purpose. Another advantage presented by the use of the cathode frames is that in the earlier stages of the electro-deposition the plates may be brought much nearer to the anodes, without fear of contact, than usual, by which the resistance of the solution is proportionately diminished, and consequently less power absorbed. Respecting the cost of the cathode frames, it is estimated that this would not be likely to exceed about twopence per frame. We understand that Mr. Watt proposes to grant licenses under this patent on reasonable terms.

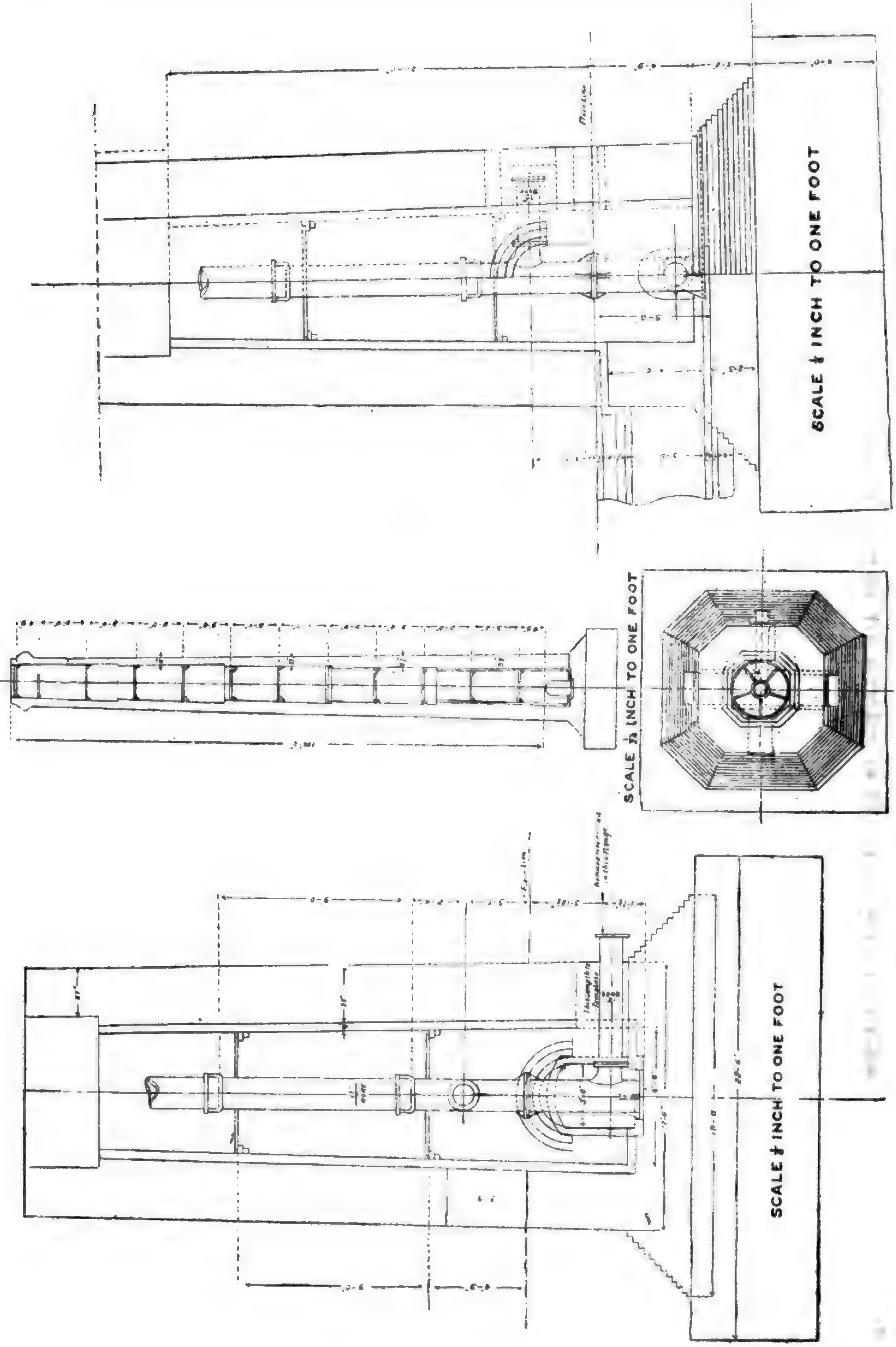
Oxygen and Magnetism.—Prof. Dewar made a highly interesting communication last week to the Royal Society. He has resumed the investigation of the properties of liquid oxygen, of which he gave some beautiful illustrations at the Royal Institution at the time of the Faraday centenary in the earlier part of this year. Faraday, more than 40 years ago, proved that oxygen alone among known gases is magnetic, and Prof. Dewar sought to determine what effect a temperature of 180deg. centigrade below zero would have upon its behaviour in the magnetic field. Having previously ascertained that liquid oxygen does not moisten or adhere to rock crystal, and consequently maintains in contact with that substance a perfect spheroidal condition, he poured the liquefied gas into a shallow saucer of rock crystal, and placed it between the poles of a powerful electromagnet. He expected some such result as the total or partial arrest under magnetic stress of the violent agitation caused by the ebullition of the spheroidal mass. But on the magnet being excited, the whole mass of liquid oxygen was literally lifted through the air and remained adherent to the poles until dissipated as gas by the heat of the metal. The feeble magnetism of oxygen at ordinary temperatures had become a force to which no solution of a magnetic metal offers any parallel. Thus was strikingly and beautifully exemplified the relation between magnetism and heat, of which the entire loss of magnetic qualities suffered by iron at a red heat is a familiar illustration. The experiment, interesting and suggestive in itself, derives an added interest, says the *Times*, from the fact that the electromagnet employed is the historic instrument with which Faraday carried out many of his classic investigations.

Thomson-Houston Goods Locomotive.—An event of considerable significance in the electrical world took place on November 28th, when the Thomson-Houston Company exhibited a 125-h.p. electric locomotive drawing a whole train of goods waggons. This locomotive is the largest electric engine built in America, though we suppose it is practically about the same size and power of the City and South London engines. The trials were made at the Lynn works of the Thomson-Houston Company, and were considered extremely satisfactory, and as likely to inaugurate a new era in electric traction work. The first test consisted in drawing two cars loaded with iron, weighing 54 tons, on a 2 per cent. gradient. The second test was with two further cars, in all 96 tons. The third test was with six loaded cars, which were moved with as much apparent ease as two only. The locomotive weighed 21 tons. It is fitted with one motor with a maximum power of 125 h.p. geared to the forward axle by powerful steel gearing. The diameter of driving wheel is 42in. The armature makes 1,000 revolutions at five miles an hour, and is reduced to 25 revolutions at the axle. The locomotive is fitted with a powerful brake. The current is taken from an overhead trolley wire, furnished with strong springs like double carriage springs pressing upwards. Some details of the locomotive are given below:

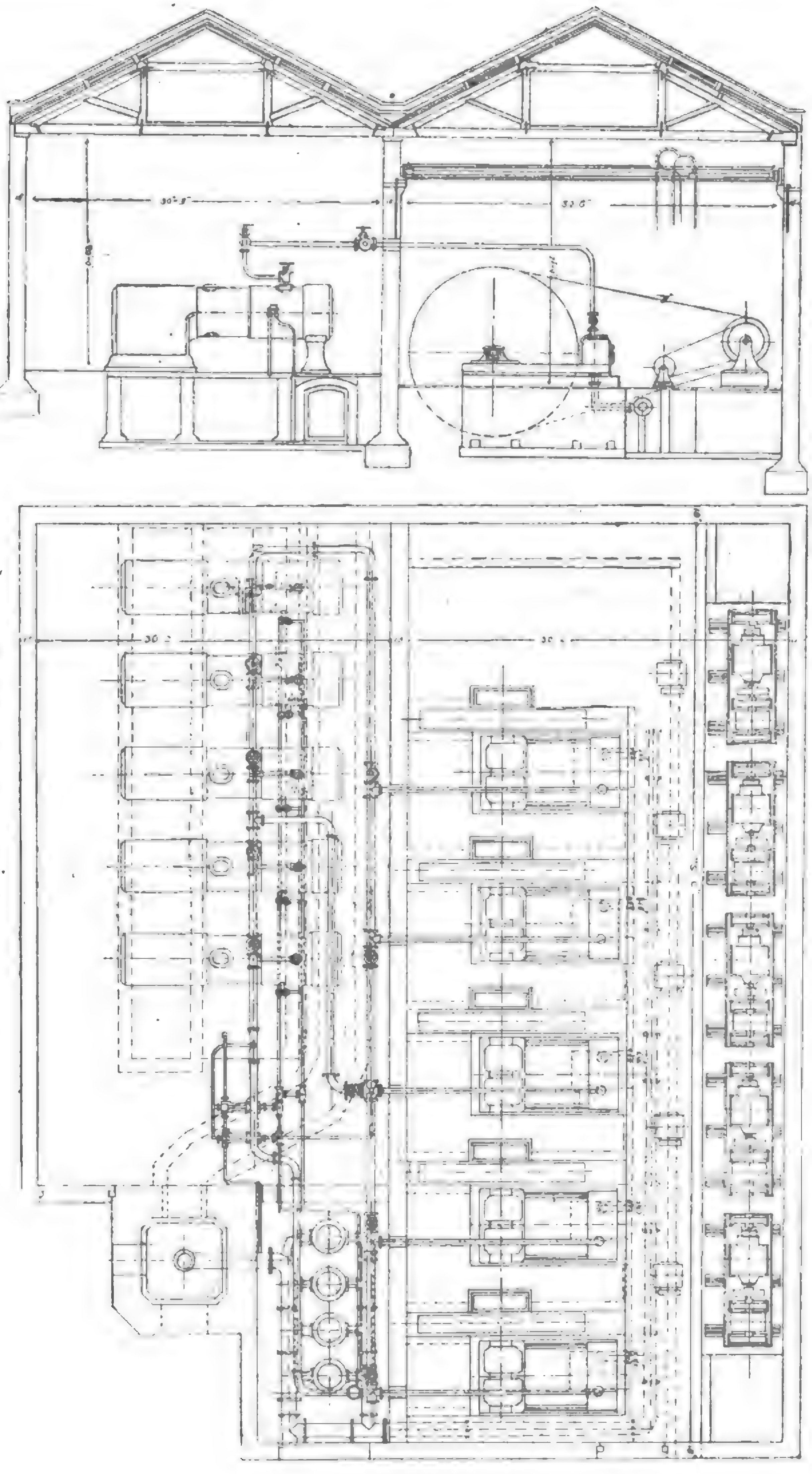
Voltage for motor	500 volts
H.P. at drawbar	100 h.p.
Speed on level at this h.p.	5 miles per hour
Wheel base	6ft. 4in.
Speed reduction	1 to 25
Gauge	4ft. 8½in.
Height above rail platform	4ft. 4in.
Greatest length (at cowcatcher)	15ft. 7¼in.
Greatest length of platform	7ft. 10¼in.
Weight of locomotive	42,525lb.
Approximate weight of motor	5,400lb.

The designing, building, and testing of this motor has been under the supervision of Mr. J. P. B. Fiske.

Rotary-Current Motors.—An installation of the "Drehstrom" or rotary-current transmission plant, is now in England, and the apparatus, weighing about two tons, is being erected in Westminster. Very careful tests will be made, and no doubt the ensuing season will see several interesting papers and discussions on the new type of motor. We might say, with probability of truth, heated discussions; as it is no secret that some of our leading electrical engineers look upon the much-advertised rotary current as more or less a fad, and maintain that it offers little advantage over other types of alternate-current motors. Mr. Mordey, in last week's *Engineering*, writing from Bilboa, objects to the limitations stated upon the usefulness of alternate synchronising motors without some qualification. With regard to the necessity of bringing them up to speed before they can use the current, Mr. Mordey remarks that although this is undoubtedly sufficient to debar their use for small motors which have to be stopped and started frequently, yet for large motors, such as for driving factories which have to be started at most twice a day, this is no serious objection. With reference to the second point, that synchronising motors stop when overloaded, this, he says, is not true in any practical sense, as only very excessive overloading will make them break step. "We have never yet," says Mr. Mordey, "been able to stop such a motor by overloading at the works of the Brush Electrical Engineering Company. When overloaded they keep in step until a point is reached beyond which destruction would result from the current being excessive to the conductors. As practical requirements do not demand nearly so much as this, we have never thought it necessary to push our trials to the destructive limit." In fact, Prof. Forbes thinks they "would rather get red-hot than get out of step." The great want of the times is a practical single-phase motor to be worked on the ordinary alternate-current circuit, and this, we are pleased to see, Mr. Mordey states is likely to be soon supplied. He has received word from a very able experimenter of what appears one really practical solution of the problem.

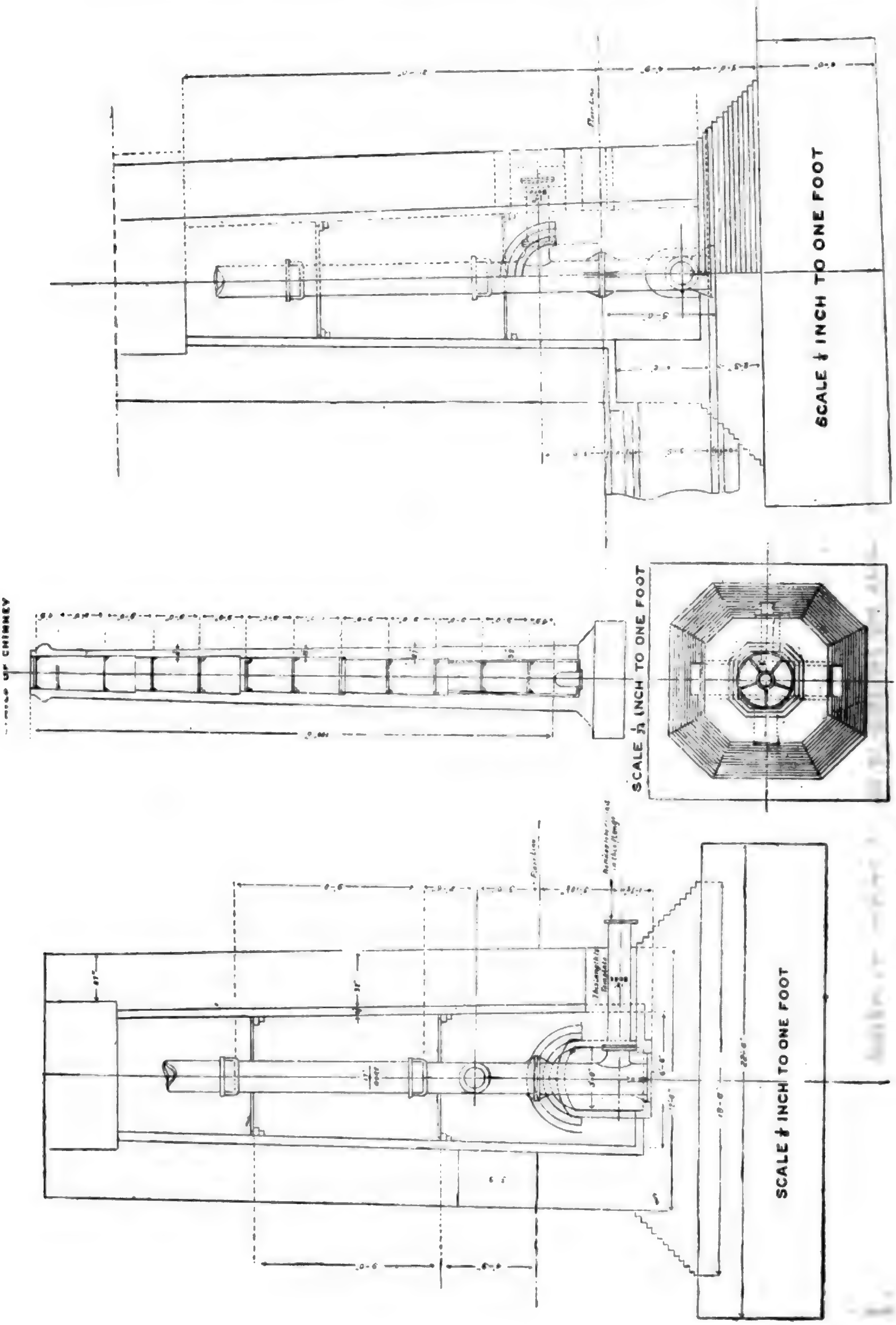

SCALE ¼ INCH TO ONE FOOT
DETAILS OF CHIMNEY
SCALE 1/16 INCH TO ONE FOOT
SCALE ¼ INCH TO ONE FOOT

THE SYDENHAM ELECTRIC LIGHT STATION.—DETAILS OF CHIMNEY.



SCALE ⅛ INCH TO ONE FOOT

THE SYDENHAM ELECTRIC LIGHT STATION.—PLAN AND ELEVATION OF BOILERS, ENGINES, AND DYNAMOS.


SCALE ¼ INCH TO ONE FOOT
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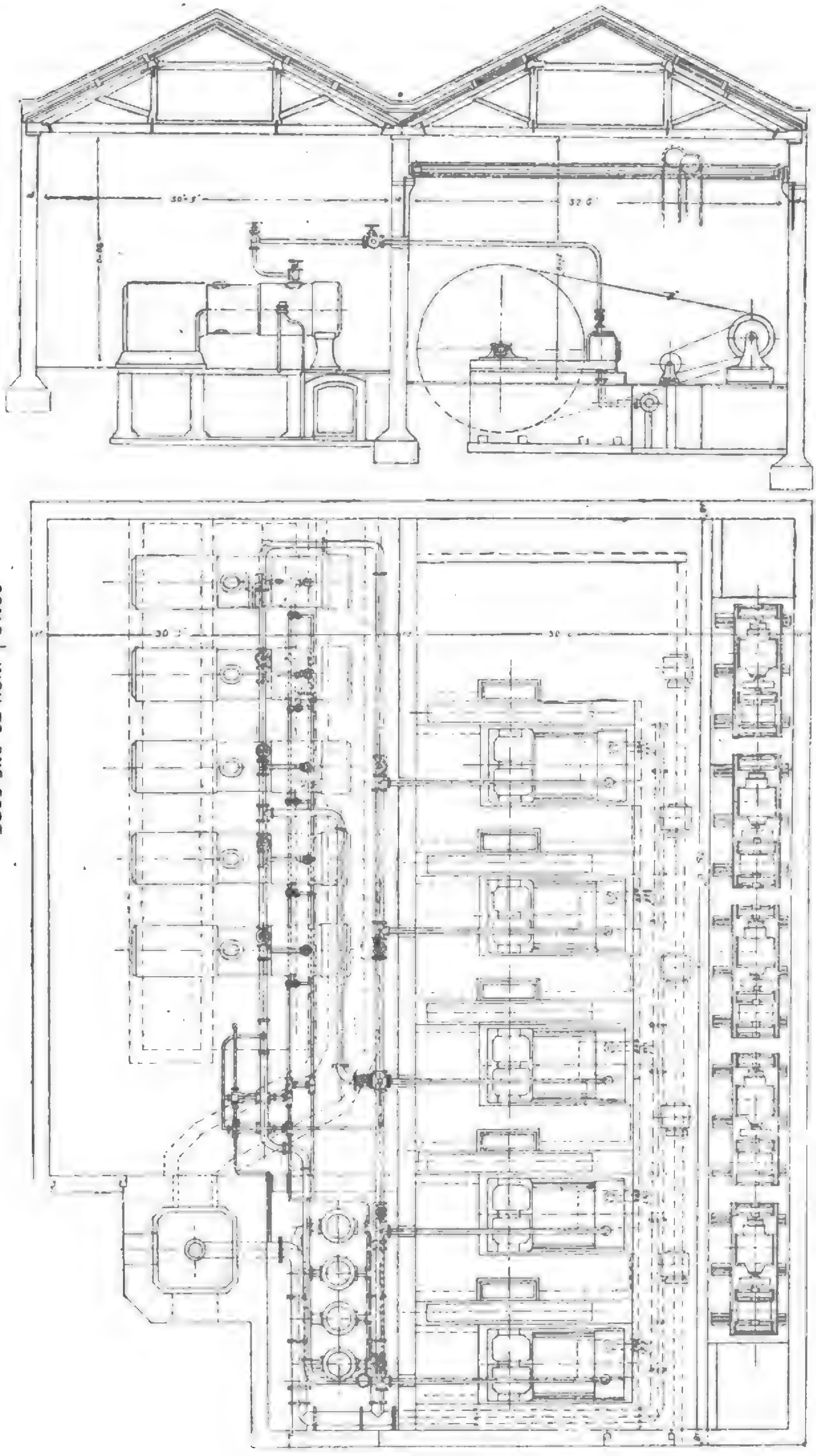
THE SYDENHAM ELECTRIC LIGHT STATION.—DETAILS OF CHIMNEY.



SCALE ⅛ INCH TO ONE FOOT

THE SYDENHAM ELECTRIC LIGHT STATION.—PLAN AND ELEVATION OF BOILERS, ENGINES, AND DYNAMOS.

ON THE SPECIFICATION OF INSULATED CONDUCTORS FOR ELECTRIC LIGHTING AND OTHER PURPOSES.*

BY W. H. PREECE, F.R.S., PAST-PRESIDENT.

(Concluded from page 567.)

The practical standard, then, of specific insulation which I propose to adopt is the resistance of an earth-quadrant (1,000,000,000 centimetres) cube of a certain insulating material which at 0deg. C. gives a resistance of one megohm. In this sense the specific insulations, σ, of various materials, calculated from dimensions and resistances, but not corrected for temperature, are as follows:

Material.	C.G.S. units.	Proposed standard.	Temp. deg. C.	Authority.
Air	∞	∞		
Mica	$8 \cdot 4 \times 10^{22}$	·084	20	Ayrton and Perry.
Guttapercha	$4 \cdot 5 \times 10^{23}$	·45	24	L. Clark.
Indiarubber	$1 \cdot 09 \times 10^{25}$	10·9	24	Jenkins
Shellac	$9 \cdot 0 \times 10^{24}$	9	28	Ayrton and Perry.
Hoopers' core	$1 \cdot 5 \times 10^{25}$	15	24	Tests.
Ebonite	$2 \cdot 8 \times 10^{25}$	28	46	Ayrton and Perry.
Paraffin	$3 \cdot 4 \times 10^{25}$	34	46	" "
Glass (flint)	2×10^{25}	20	20	T. Gray.
Siemens's special high insulating rubber		16·17	15	
Siemens's ordinary pure and vulcanised rubber		2·28	15	
Siemens's specially high insulating fibrous material		11·90	15	
Fowler-Waring dielectric		7·33	15	
Glover vulcanised rubber		1·63	15	

To obtain the true value for σ these results, of course, ought to be corrected to 0deg. C.

ELECTRIFICATION.

Insulated conductors should always be subjected to the process of electrification for one minute before the scale reading from which the insulation is to be calculated is noted. The leakage current polarises the dielectric; the insulation apparently improves—rapidly at first, then more slowly—and unless some conventional time was agreed upon for the test, proper comparison could not be made. One minute is universally accepted as the period. The rate of fall due to electrification is a great test of the quality of the insulating material. It varies with the nature and quality of the material, being more marked at low temperatures. Unsteady electrification is a sign of an incipient fault, and perfectly regular electrification is an indication of good material. The resistance of the dielectric apparently gradually increases, owing to the formation of an opposing E.M.F. in what is probably a liquid electrolyte. As the rate at which electrification proceeds is an uncertain quantity, and in the best material is very low, it is better to specify that the electrification shall progress steadily, without stating the rate at which it proceeds. The temperature at which the test is to be made should also, of course, be given, 75deg. being the usual standard.

THICKNESS OF INSULATION.

More important is it to determine and specify the thickness of the insulating coating. Two conditions determine this—the E.M.F. to be used and the mechanical conditions of manufacture. We have also to consider sparking distances in air, especially in the case of high-pressure mains, when heat, age, accident, and use cause decay and cracks, and the conductor becomes exposed through fissures. I cannot contemplate a less thickness of any material than 1 mm., or ·04 of an inch, for a No. 19 wire. That means that a millimetre conductor requires as a minimum a millimetre thickness of insulating coating. Now the striking distance of a millimetre in air is over 600 volts. As the conductor increases in diameter the thickness must increase in greater ratio, not because the E.M.F. requires it, but because the exigencies of manufacture and the mechanical construction of the core demand more stuff to resist the stresses brought to bear upon it. Given a conductor with a certain thickness of dielectric able to resist the stress of x volts, the same thickness will equally resist the same voltage whatever the diameter or sectional area of the conductor.

The actual thickness to be used above the crucial thickness required for the security of those who accidentally or purposely handle the wire is a manufacturer's question; the engineer can specify only the minimum thickness. The Board of Trade rule for aerial conductors is the following:

"Every high-pressure aerial conductor shall be continuously insulated with a durable and efficient material, to be approved by the Board of Trade, to a thickness of not less than one-tenth part of an inch; and in cases where the extreme difference of potential in the circuit exceeds 2,000 volts, the thickness of insulation shall not be less in inches or parts of an inch than the number obtained by dividing the number expressing the volts by 20,000. This insulation shall be further efficiently protected on the outside against injury or removal by abrasion. If this protection be wholly or partly metallic, it shall be efficiently connected to earth.

"The material used for insulating any high-pressure aerial conductor shall be such as will not be liable to injurious change of physical structure or condition when exposed to any temperature between the limits of 0deg. and 150deg. F., or to contract with the ordinary atmosphere of towns or manufacturing districts."

The two points, then, to be met are those of specific insulation and of thickness; the former determining the quality of the material, and the latter being governed by the striking distance.

It is an extremely difficult thing to arrive at a definite conclusion as to the exact sparking distance across an air-space with a given potential difference. It varies with the character of the opposing surfaces; with the resistance, capacity, and electromagnetic inertia in the circuit; with the nature of the current—that is, whether it is steady or alternating, and also in the latter case with the frequency. Sir W. Thomson concludes "that a Daniell's battery of 5,510 elements can produce a spark between two slightly convex metallic surfaces at one-eighth of a centimetre asunder in ordinary atmospheric air" (papers on "Electrostatics and Magnetism," page 259), which means that it requires 4,928 volts to strike across one millimetre.

Warren de la Rue obtained a result very similar. Prof. Crookes, using an induction coil, takes much lower figures, and estimates the striking E.M.F. at 1 mm. as 920 volts. Mr. Ferranti, using a frequency of 200 and 20,000 volts, brought the voltage down to 620.

I propose for underground and covered conductors to specify as a minimum for 500 volts, or any E.M.F. under, 1 mm. thickness of dielectric, and ·5 mm. for each succeeding 500 volts or portion of 500 volts. Thus we should have for—

THICKNESS OF DIELECTRIC FOR DIFFERENT VOLTAGES.

Voltage.	Mm.	Inch.	Board of Trade. (inch)
500 and under	1	·04	·04
1,000	1·5	·06	·05
1,500	2	·08	·075
2,000	2·5	·10	·10
2,500	*3	·12	·125
5,000	*5·5	·22	·25
10,000	*10·5	·42	·5

* Material of superior quality—*i.e.*, 6 over 10.

CLASSIFICATION.

The classification of insulated conductors is most varied and perplexing as regards the dielectric. The most systematic method is that of Siemens, as regards the conductor. The pattern number gives the length in yards, which has a resistance of one-tenth of an ohm; divided by 4, it gives its carrying capacity in amperes; divided by 5, it gives its weight in pounds per mile; divided by 6, it gives its sectional area in mm.^{2}; divided by 4,000, it gives its sectional area in square inches. Nothing can be more charming. But when we come to insulation, we have types G, H, J, P, Q, R, L, M, N, LL, MM, NN, LLL, MMM, and NNN—all differing in the number and thickness of layers of pure rubber, of vulcanised rubber, of "special prepared material," in taping, braiding, preserving with compound, lead, tarred jute yarn, and iron sheathing, and also in insulation resistance per statute mile in megohms at 60deg. N, NN, and NNN, are intended for 250, 2,500, and 5,000 volts respectively, and they vary in price in the ratio 64, 79, 93.

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* Paper read before the Institution of Electrical Engineers on Thursday, December 10, 1891.

TABLE A.—SPECIFIC INSULATION (σ) OF ELECTRIC LIGHT CABLES MANUFACTURED BY VARIOUS FIRMS.

Manufacturer.	Conductor.			Dielectric.				Insulation per mile at 60 deg. F., megohms.	Specific insulation (σ).	Remarks.
	No. of wires and approximate gauge.	Diameter (d).		Thickness (t).		Diameter (D).				
		inch.	mm.	inch.	mm.	inch.	mm.			
Siemens Bros. ...	7/22	·084	2·14	·076	1·93	·236	5·99	16,180	15·84	Insulated with "Siemens's special" high insulating indiarubber.
,, ...	,,	,,	,,	·078	1·98	·240	6·10	18,270	17·60	
,, ...	19/15½	·340	8·64	·080	2·03	·501	12·72	1,022	2·67	Ordinary pure and vulcanised rubber.
,, ...	61/15½	·612	15 54	·168	4·27	·949	24·10	824	1·90	
,, ..	51/12	·850	21·59	·190	4·82	1·230	31·24	4,082	11·17	Lead-cased; insulated with specially high insulating fibrous material (Bradford Corporation mains.)
,, ...	37/13	·651	16·53	·096	2·44	·844	21·43	2,567	10·00	
,, ...	19/14	·410	10·41	·079	2·01	·568	14·42	3,794	11·77	
,, ...	7/13	·286	7·26	·079	,,	·444	11·28	6,389	14·69	
,, ...	60/6½	1·656	42·06	·113	2·87	1·882	47·80	624	4·93	Lead-cased; insulated with impregnated fibrous material. (St. James's and Pall Mall Company's mains.)
,, ...	,,	,,	,,	,,	,,	,,	,,	830	6·56	
,, ...	60/10	1·170	29·72	·114	2·89	1·398	35·51	851	4·83	
,, ...	,,	,,	,,	,,	,,	,,	,,	1,014	5·76	
Silvertown	19/15	·360	9·14	·144	3·66	·648	16·46	6,768	11·64	Special pure indiarubber, then vulcanised indiarubber.
,, ...	,,	,,	,,	,,	,,	,,	,,	6,664	11·46	
,, ...	,,	,,	,,	,,	,,	,,	,,	6,549	11·26	
Callender	7/16	·192	4·88	·154	3·91	·500	12·70	380	·40	Vulcanised bitumen.
,, ...	19/18	·240	6·10	·155	3·94	·550	13·97	400	·49	
Glover	19/13	·460	11·68	·115	2·92	·690	17·52	600	1·50	Ordinary pure and vulcanised rubber, in use at the G.P.O. (specified 300 megohms per mile.)
,, ...	,,	,,	,,	,,	,,	,,	,,	515	1·28	
,, ...	,,	,,	,,	,,	,,	,,	,,	560	1·40	
,, ...	7/16	·192	4·88	·055	1·40	·302	7·67	855	1·91	
,, ...	,,	,,	,,	,,	,,	,,	,,	813	1·81	
,, ...	,,	,,	,,	,,	,,	,,	,,	833	1·86	
Fowler-Waring..	1/18	·048	1·22	·036	·91	·120	3·05	6,522	7·20	
,, ..	1/16	·064	1·62	·043	1·09	·150	3·81	6,619	7·85	Waring compound.
,, ..	7/16	·192	4·88	·078	2·03	·352	8·94	4,835	8·07	
,, ..	19/18	·240	6·10	,,	,,	·400	10·16	3,280	6·48	
,, ..	19/16	·320	8·13	·095	2·41	·510	12·95	3,312	7·18	
,, ..	19/15	·360	9·14	·100	2·54	·560	14·22	3,145	7·19	
Henley	1/10	·128	3·25	·046	1·17	·220	5·59	564	1·05	Ordinary pure and compound indiarubber.
,, ...	7/16	·192	4·88	·054	1·37	·300	7·62	406	0·92	
,, ...	19/18	·240	6 09	·060	1·52	·360	9·14	329	0·82	
,, ...	1/14	·080	2·03	·040	1·02	·160	4·06	4,440	6·48	Ozokerited indiarubber.
,, ...	3/20	·078	1·98	·039	·99	·157	3·99	5,240	7·57	
,, ...	7/15	·216	5·49	·057	1·45	·330	8·38	2,210	5·27	
,, ...	19 14	·400	10·16	·080	2·03	·560	14·22	2,000	6 01	
,, ...	61/15	·648	16·46	·111	2·82	·870	22·09	2,200	7·55	
,, ...	61/12	·936	23·77	·217	5·51	1·370	34·79	7,146	19·98	Special cable—Class AA.

We are, however, told that they are tested in water when not intended for dry places, and Messrs. Siemens show that the insulation resistance diminishes as the size of the conductor increases.

For instance, type R: "Insulated with one layer of pure and two of vulcanised rubber, taped [braided, and drawn through preservative compound]. Tested under water, insulation resistance from 2,000 to 700 megohms per statute mile of 60deg.F., according to size of wire." The words in brackets form the sole difference between types J and R.

The Silvertown Company work up by areas of conductor, advancing by twentieths of a square inch, between 1/10th square inch and one square inch. The insulator is composed of pure rubber, their best vulcanised indiarubber. They used to endeavour to maintain a constant ratio of diameters of conductor and dielectric, but the insulation resistance now varies with size. The wires are all rigidly tested under water, and give over 2,500 megohms per mile.

But the classification into letters is as perplexing as with nearly all the other makers, except, perhaps, the Fowler-Waring Company, who have only one dielectric and one form of protection—viz., lead covering.

The Standard Underground Cable Company, of U.S.A., who use Waring's compound, specify the thickness of insulation in mils. Their smallest is 31 mils, nine mils less than the proposed minimum. Their thickest is 188 mils, or 7·5 mm., which is good enough for 7,000 volts.

This classification into types is a manufacturer's question. We cannot interfere with it, but we do earnestly hope that they will study the convenience of the user by reducing their types to the lowest possible number, but, above all, by removing from their lists the cheap and nasty.

The evil of this loose system was strikingly exemplified in a case which recently came before the law courts, when some of the ablest counsel were busily employed for several hours in endeavouring to explain what was meant by "C" quality wire, with but little result, none of the expert witnesses present being able to throw any light on the subject.

I am much indebted to different firms for the information which they have cheerfully given me to enable me to determine the specific insulation of the different materials they use; and as this information may be very useful, I tabulate it, and submit it herewith (Table A).

This table must not be taken as a competitive examination of the relative merits of the different goods. I have taken them just as they came, and I have not indicated the classification, simply because I did not know it.

SPECIFICATION.

The consulting engineer can afford to smile at classification, for he can draw up his own specifications; but it is extremely difficult even to do this without a reference to some well-known maker's class.

No wire should ever be used which cannot be subjected to a test under water. Insulated wire is supplied which is specified *to be used in dry places only.* But as this stuff is cheap, inspection is ignored, and dry places are not always dry; its general use follows; dampness and leakage result, electrolysis sets in, and the conductor is eaten away, if it is not charred, or even set on fire.

It is impossible to speak too strongly on the terrible abuse of ordinary precautions which is encouraged by the manufacture of these cheap cables. It destroys confidence, introduces danger, and discourages the industry.

A very curious practice has recently developed itself among our wiring contractors. They have asked manufacturers to reduce the over-all diameter of their insulated conductors, in order to enable them to utilise the grooved boarding which they happen to have in stock. In other words, the interests of the users of the electric light are to be sacrificed to the interests of the wood-carvers!

I do not believe in danger to person in high-pressure systems when proper material is used. They are so safeguarded, that any contact between primary and secondary—practically the only source of danger—leads at once to safety. I fear more danger of fire in both systems, and this more in low-pressure systems than in high-pressure ones, for they are not so safeguarded, and are more open to abuse. In fact, the numerous accidents that have occurred from imperfect work on low-pressure systems has already attracted serious attention to its dangers.

I prefer, then, to specify that:

1. The copper must be pure, and such that at a density of 8·9 its specific resistance is 1,616—that is, it must comply with Matthiessen's standard of pure hard-drawn copper.
2. If it is to be covered with any vulcanised material, it must be tinned.
3. No single size smaller than No. 19 (·04in. or 1 mm. wire) is to be used.
4. No single wire greater than No. 16 is to be used.
5. All larger sizes are therefore to be stranded.
6. The weight of copper used is to be such that the loss of volts between the distributing switch and the furthest lamp, when full load is on, shall not exceed 1 per cent. Hence the current which each conductor has to carry must be given.
7. The dielectric to be employed must be described, with its specific insulation, in terms of a quadrant cube of gutta-percha at 75deg., which is taken as unity.[*]
8. The thickness of dielectric must be given for the different sized conductors used.
9. The various modes of preserving and protecting the insulated cables must be given.
10. Every coil should have attached to it the maker's certificate, testifying that it complies with this specification, and that it has been tested under water.[†]

TESTING.

There are upwards of 130,000 miles of cables submerged in the ocean, and I cannot recall to mind a single fault that has occurred since 1865 through a manufacturer's defect that has escaped the probe of the tester. Every cable is most rigidly and carefully tested under water. Why do not users do the same with their electric light conductors? It would be the greatest safeguard for security.

There is a widespread impression that the insulation varies inversely with the potential differences employed, and that the higher the voltage used the more accurate the result. This is a mistaken notion. The following experiment was made to show its fallacy:

TABLE SHOWING RESULTS OF INSULATION TESTS OF GUTTAPERCHA CORE WITH VARIOUS VOLTAGES.

Number of cells. (Leclanché.)	Galvanometer readings.			Insulation after one minute's electrification.
	1st min.	2nd min.	3rd min.	
				Megohms.
10	18½	16	14½	164·3
40	76	67	64	162·2
100	179	163	157	173·3
200	181 7,000ω	168	162	168·2
300	192 4,000ω	181	177	172·2
400	188 3,000ω	177	173	174·1

The advantage of high voltage is that it breaks down incipient faults; but, on the other hand, if too high, it may put in faults; it is therefore advisable that the insulation be tested with a voltage, say, not less than 50 per cent., and not more than 100 per cent. above the voltage it is intended to resist.

[ERRATA.—Page 566, for

$$\sigma = \frac{\rho l \, 2\pi}{\log_\epsilon \frac{D}{d}}$$

where ρ is the specific resistance in C.G.S. units, etc., read:

$$\sigma = \frac{R^1 l \, 2\pi}{\log_\epsilon \frac{D}{d}}$$

where R^1 is the resistance in C.G.S. units, etc.

For "ρ" in the note * "A simple approximation," etc., substitute "R^1."]

LITERATURE.

Electricity up to Date. By JOHN B. VERITY, M.I.E.E. Frederick Warne and Co. 1s. 6d.

Electrical books have hitherto not had a very large popular demand. Technical introductions to the science and practice of electricity have now, however, begun to be followed by books for the consumer, and in the work before us we have an extremely useful pocket electrical hand-book. Its exterior is popularly attractive, with the appearance of not being too "dry," for it is a small volume in white parchment cover, with title in red and black, something after the nature of "English as She is Spoke," or "Dancing as It Should Be." The title "up to date" certainly appeals to the average enquirer, and when he has invested his eighteenpence and turns to the matter he will find a vast deal of the information he requires in readable and interesting form. Mr. Verity begins, of course, with *electron*, and then shortly explains the various means of producing electricity. His explanations, though sufficiently correct, are not always scientifically so; for instance, the energy of a primary battery is not obtained by the "destruction" of zinc, but by its oxidation. Again, Mr. Verity uses continually the term "inductional" electricity. He says current is produced in a dynamo by magnetic induction; it would be better at once to state that such current is obtained by forcible *motion* in a magnetic field, whence the name dynamo. The action of the dynamo is popularly explained in a separate chapter with some detail, but the chief difficulty in the way of the ordinary person—that is, the difference between direct and alternating currents—is perhaps complicated by the statement that "so rapid, in fact, are the alternations that the current generated is practically a steady and *continuous* flow"—which certainly (in the sense it would be read) it is not. Mr. Verity mentions the various sources of power, and gives an illustration of a Victor turbine. The arc light is next treated, and the first practical use for it is quoted as that in 1858 for the construction of Westminster Bridge. The Edison-Swan lamp and the Sunbeam lamp are succinctly described, and the sanitary advantages insisted upon. In the chapter on "Storage" we again come across the popular mis-statement (started by the public press at the time of Sir William Thomson's wonderful box), that "electricity is stored"—a statement that should not be found in any works now issued to the public. The ordinary mind should have no difficulty in grasping the true theory of chemical reactions. The after explanation of the E.P.S. cell becomes thus vitiated by the first sentences. In the matter of wiring a house, Mr. Verity shows himself perfectly at home, and the chapter on this part of the electrical engineer's work is admirable, and he rightly insists on the necessity of employing experienced and competent engineers. We notice an amusing joke, incidentally introduced, *apropos* of the householder's ignorance of technical terms: when informed that a leak was due to "earth," the question was asked, "Then why wasn't the earth removed from the house before the wires were put in?" The action of switches and wall sockets are explained and illustrated, and a chapter on private installations gives a plan of the arrangements required, with a photograph of the author's 50-light installation at Weybridge. To ordinary people, however, the public supply most interests them, and this question receives as full attention as the average householder requires, with explanations of the high-pressure, low-pressure, and three-wire systems, which, if not technically instructive, serve their purpose. The chapter contains a list of the principal central supply companies, with names of their chairmen and amounts of their capital, district supplied, number of lamps connected, price charged, etc. Supplemented, as it is, with a coloured map showing the districts in London over which the companies have power, it makes this part of Mr. Verity's little book useful for reference. We are then given two short chapters upon transmission of power and electric traction, with illustrations of hauling plant for mines and an overhead electric tramway line. A *résumé* of the Board of Trade regulations follows, with a comparison of the advantages of electric light over gas. A final chapter on electrical engineering as a profession is written from an eminently common-sense standpoint. "It is pitiable," says Mr. Verity, who is in a position to know by experience, "to see the number of young men of all social conditions now seeking and begging for electrical work. As a rule, their training has been a two or three years' course at a technical college, where they have learned something which, no doubt, will be of advantage to them in the future, but who are not in any way qualified for the work they are seeking." It is painful for us to have to reiterate again and again these opinions, and Mr. Verity, speaking as head of a firm which employs hundreds of men, fully bears out the ideas we have so often expressed, that it is theoretical work placed as a crown upon practical knowledge that will enable a young man to succeed. "A firm," says Mr. Verity, "would infinitely prefer men who were good mechanics who, from liking for the subject, have read electrical books," to simply theoretical students who have passed examinations and paid their hundreds as premiums without acquiring actual practical experience. Mr. Verity concludes his advice with a list of technical periodicals and hand-books (in which, by the way, we notice Dr. Thompson's name spelt in two different ways). The book ends with a glossary of technical terms, and a full index. In the glossary, which generally is all that is required, several errors or hazinesses have crept in, of which a second edition will give the chance of revision: Cell is usually a glass or porcelain jar, not a "box." The definition of charging, "filling or storing an accumulator with electrical energy," is almost correct, but not quite. Countershafting is usually considered one word. Earth should have the words "usually to the ground" added. "Electricity, inductional," that produced by the dynamo, should be rather "dynamo-electricity." "Electrolyte" should have the words "the term usually applied to the acid solution in batteries." "Filament" might have the words "capable of being rendered incandescent by the passage of a current without fusion." Induced current is defined as "electricity produced by the influence that one magnetic or electrified body has on another not in contact with it"; a mixture of statements that is far from holding good. Again, "parallel wiring" is defined as a term used to express the system in which each lamp has its individual flow and return wires, whereas, in reality, it is that in which all the lamps in a house have the same main flow and return wires. It can be seen from what we have said that "Electricity up to Date" contains an astonishing amount of matter; some of the illustrations are rough, but that they should be there at all in an eighteen-penny book is noteworthy. The printing is excellent, and the book is probably assured of a wide sale.

---

[*] This can easily be deduced from its insulation in megohms per mile when the dimensions and the temperature coefficient for the material are given.

[†] Messrs. W. Glover and the Silvertown Company already do this.

Popular Electric Lighting: Being Practical Hints to Present and Intending Users of Electric Energy for Illuminating Purposes, with a Chapter on Electric Motors. By Captain IRONSIDE BAX, General Manager of the Westminster Electric Supply Corporation, Limited. Illustrated. Biggs and Co. 2s.

We have in the above work an electrical book written with a definite object, which is closely kept sight of throughout—that of enlightening the consumer of electrical energy on his rights, duties, and the knowledge he should possess to properly superintend and understand his service. In this respect we do not find it so much a text-book of technics, as of the nature of those eminently useful works issued from time to time dealing with law, banking, or other more or less recondite matters, on which it is necessary for the modern man to have information. Certainly few men would be in a better position to deal with electric supply in this manner than Captain Bax, who with his experience in the position of manager of an electric supply company has necessarily constantly to consider and deal with all the questions arising under these circumstances. The book starts with a very full and accurate—at the same time common-sense and direct—explanation of the terms used in electrical working. Dealing first with the advantages of the electric light in health, safety, and cleanliness, Captain Bax at once proceeds to explain the difference between high and low tension systems. An avowed advocate of the low-tension system, the author leaves no vague idea as to which he considers the best system for private houses, and without considering collateral advantages from the distributive, and, therefore, financial point of view, emphasises danger, need of precaution, and absence of storage power. There is little doubt that the low-tensionists have a powerful lever on the public mind by working on feelings of caution, and whatever the advantages of high tension for transmission, the low tension will always hold favour amongst the public for this reason. Captain Bax makes the best of his entrenchment, and insists that "it is not advisable to rely upon a company possessing but one generating station." He sketches out the arrangement of central station, storage battery, and mains that are requisite for low-tension working as compared with high-tension, balancing rent of transformer against the slightly lower rate of charge.

Taking at once the position of a householder who is aware that laying of electric mains is proceeding in his vicinity, he informs the intending consumer what work the company have to do to bring it to his threshold, and what notices he himself has to give to the company to obtain the light. The most important part to the consumer, that of the interior fitting of his house, is next dealt with from the same standpoint—wiring, lamps, and switches being thoroughly described, with special insistance upon those details, as between contractor and consumer, that first have to be gone into when a house is to be lighted. Safety fuses and means of economically and safely arranging circuits are explained succinctly. Incidentally, we notice the author regrets no practical means are yet before the trade for the repair of incandescent lamps—eminently a householder's question. Measurement of the current receives, as it deserves, very special consideration. Illustrations of the Aron meter and its dials are given, and directions for reading the figures, with explanation of its action, supplies exactly that information which most consumers first require. With reference to comparative cost of gas and electricity, Captain Bax quotes from his own experience an instance where the gas for a private house used to cost £35 a year, and the electric light now comes to but £43 a year—that is, exceeds gas little more than one-fifth. By careful arrangement of lamps and switches, with attendance to rules for turning off the current when not used, this proportion should be obtainable generally. The information with reference to electric light is supplemented by a chapter on motors, the use of which we expect to become general in every house that uses electric light. The utility of the book is very considerably enhanced by the addition of an appendix giving actual estimates for the wiring and fitting up of installations for connection to the central supply mains for houses of 8, 12, 15, 20, and 25 rooms. A further appendix with a map gives tabulated particulars of the various London electric supply companies and their systems. It is a book that not only appeals to the general public, but to municipal authorities requiring straightforward information for their members; and supply companies and electric contractors intending to supply the consumer would do well to see that he has such a work in his hands.

Decorative Electricity. By Mrs. J. E. H. GORDON. Illustrated. New and cheaper edition. Sampson Low.

We have already noticed with favour the handsome volume on artistic electric fitting written by Mrs. J. E. H. Gordon, and illustrated by Mr. Herbert Fell. By the large number of dwellers in modern artistic residences, the gas-fitting type of electric pendant is regarded as an abomination, and rightly so. To them the electric light, with the light and tasteful incandescent lamps, comes as a revelation, and the full advantage of its beauty should be taken. Mrs. Gordon takes these gentlemen, or more particularly (for it is with them that the question lies) these ladies through their houses—from hall, drawing-room, dining-room, boudoir, to attic, and in pleasant terms, accompanied with delightful illustrations, shows how to light up the house in truly artistic style. The book has already been very well received in its first and expensive form, and in the cheaper edition will not fail to receive a welcome in many homes.

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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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TENDERS—HIGH AND LOW.

It would be a piece of affectation on our part to refer to the *Contract Journal* as we should refer to a paper outside our influence, when it is generally known that that journal is closely connected with this paper. The *Contract Journal* deals almost exclusively with matters relating to contracts ; hence, in its issue of December 16 was given the list of tenders for the extension of electric lighting at the central offices of the London County Council. There were thirty-two of these tenders, ranging from £1,490, the lowest, to £2,996, the highest. A difference of two or three hundred pounds, or even of five hundred, upon so comparatively small a job might be understood, but what reasonable hypothesis can explain a difference of £1,506? If the lowest tender, or even half-a-dozen of the lower tenders, permit the work to be done properly at a reasonable profit, what about the profit upon the higher tenders? If, however, the higher tenders have been carefully got out and only a reasonable profit added, what about the lower tenders? It is scarcely conceivable that tendering upon the same specification permits such wide differences, yet here is proof that it does. Immediately below the series of tenders above referred to our contemporary gives another series from eleven builders, the difference between the highest and lowest being £1,777; but in this case the highest is £7,977, so that the percentage difference is far below that which holds in the electrical tenders. Further, to those who understand the work, the reason of differences, and somewhat large differences, in building operations is easily explained, but similar reasons are not to be found for large differences in electrical work of the kind under consideration. In the latter case, a diminution of the higher tender about 22½ per cent. would bring it on a level with the lower, but the former would require a diminution of about 50 per cent. to bring the highest down to the lowest. It would be interesting, if it were possible, to obtain the continuation of the history of such work—by this we mean an exact and authentic statement of the cost of the work to the contractors. We are not going to hint that mistakes have been made in this case, but for the present prefer to imagine that most tenders were made upon the idea that the London County Council, being a wealthy corporation, was one that could well afford to pay for work done. That argument will sufficiently account for many of the vagaries of the tendering. We think we have sufficient knowledge of the "policy" of our contemporary to know that if it takes up this question some hard things will be said of electrical engineers, and justifiably so. The London County Council may be a wealthy corporation, but it is spending the money of the ratepayers, and there is no reason why they should be asked to pay more than is necessary because they pay collectively rather than individually. There is a tendency among certain classes of shopkeepers to charge a customer according to his looks, and it certainly seems as if the same view was held by some electrical engineers. There is another way of mildly explaining these differences. It is that a number of minor, younger, or country firms are extremely anxious to get a piece of work which may prove a good stepping-stone to something in the future. Business push of this kind is commendable, but if the work is undertaken at a loss, the system is a hazardous one. Men nowadays are kept tolerably well acquainted with what this or that work costs, and commencing at a low price and gradually putting up the price is apt to lead to loss instead of gain of business. There must have been some undercurrent of reason to account for the different figures. It may be news to some of our electrical friends to hear that many authorities keep a "black-list," and once a firm's name gets upon the list all chance of obtaining work from that particular source is gone. We have assumed that each contractor tendered for the best work and the best materials, otherwise other suggestions might be made as to the differences. A large part of the electrical work of the future will be in connection with local authorities, where prices cannot be kept secret as with private individuals—hence it will be well to pay closer attention to the proper methods of making out tenders.

THE FINANCE OF THE LONDON COUNTY COUNCIL.

We all know what happens when a ship is sinking—the cry is *sauve qui peut*. A sinking ship and a senile Council have much in common. For the latter, the coming election looms ominously in view. There are cases, however, in which bravado takes the place of wisdom, and this seems to be a feature in many of the acts of the expiring London County Council. The reason may be that many of the members know what the future has in store for them. They will pass into a limbo whence the electors will not recall them. Not long since we recorded the peculiar action of the Council in regard to the St. Pancras loan. We are glad to see that St. Pancras has been independent of the Council. It will be remembered the Finance Committee recommended the loan; the Council though admonished as to importance of time, referred back the report. Again the committee recommended the loan, and the Council agreed to the report, but meanwhile St. Pancras altered its mind and now said to the Council, No, thank you. The granting of a loan by the County Council is no favour to St. Pancras. The latter is not a supplicant nor to be treated as such, and has quite rightly snubbed the Council. It was part of the duty of the late Metropolitan Board of Works to loan out money to local authorities; it is part of the duty of the County Council to do the same. There is no favour conferred by so doing—rather it is a right. Similarly the County Council are riding the high horse with the School Board, but here again their action is landing them in ridicule. Perhaps the constituencies will not have forgotten these matters some four months hence, and will plainly tell the new councillors that they are elected for certain business purposes, and not for the purpose of airing fads or throwing obstacles in the way of local improvements.

CORRESPONDENCE.

"One man's word is no man's word
Justice needs that both be heard."

THE ELECTRIC OMNIBUS.

SIR,—In reply to W, "Where is the electric omnibus," I beg to suggest to him that the duty placed on a locomotive engine is so heavy that the said engine is shut out of the market. However, here is the law: a locomotive engine may travel along the road on condition that an attendant is attached to it, and also that a man walks in front carrying a RED FLAG (size of flag *ad lib*), the pace not to be more than *four miles per hour*. Fancy a hansom cab subject to those conditions, "four miles per hour and man with red flag in front." Oh! thou *free and enlightened country*. Now the way out of the difficulty is this: the general election is close at hand; let each of us interested in electricity interview his respective candidate, and get a promise from him that he will assist in getting the law amended. It not being a party question, it will apply to both sections of members of Parliament.—Yours, etc.,

C. MARSON,
Member of the Vestry of St. Mary's, Battersea.
22, Swaby-road, Northcote-road, Clapham Junction,
December 13th, 1891.

[Mr. Marson has evidently not read his *Electrical Engineer*, or he would have learnt that the legal aspect of the case is not as he states. A license can be obtained for electric vehicles, and, in fact, an electrical omnibus has often traversed the principal London streets.—ED. *E. E.*]

D.P. ACCUMULATOR CELLS.

SIR,—We notice in your last issue you publish the paper read by Mr. Robertson at the Society of Arts without the discussion, and as the description of our cell is likely in its present form to create a bad impression, we trust you will allow us space to correct the statement that our positive plates are of the Faure type. As pointed out in the discussion by Mr. Drake, the plates, both positive and negative, are of the Planté type, no oxides or salts of lead being employed in their construction.—Yours, etc.,

DRAKE AND GORHAM.
London, S.W., 11th Dec., 1891.

DREHSTROM.

SIR,—Under the above heading you published last week a paragraph stating that I am about to make tests with a multiphase-current set. This is misleading. The set in question has been very kindly lent me by the Berlin Electrical Company for illustrating one of my lectures on alternating currents at the School of Military Engineering at Chatham, but I have received no instructions to make tests with it.—Yours, etc., GISBERT KAPP.
Westminster, Dec. 15, 1891.

GWYNNE AND CO.'S DISCLAIMER.

SIR,—Our attention has been called to a letter which appeared on page 563 of your last issue, signed by Messrs. Gwynne and Co., of Victoria-embankment, informing you that they were not shareholders in our company. This disclaimer is quite correct so far as the firm of Gwynne and Co. is concerned, and we are somewhat surprised that they thought it worth while to rush into print to refute a matter which in no way concerns their firm unless it was done by them with some ulterior object, and we would remind these gentlemen that there are more "Gwynnes" than one engaged in the engineering world. However, to put this matter right, from a financial point of view, and so far as our company is concerned, we beg to state that the particular Mr. Gwynne who is interested in the success and welfare of our company is Mr. James Eglinton Anderson Gwynne, J.P., of 97, Harley-street and Folkington Manor, Polegate, Sussex, and the owner of the Pilsen Electric Works, who, moreover, since the date of the first announcement in your "City Notes," has also taken over our Mr. Arthur Shippey's entire interest in the company, also Mr. Shippey's vested interest in the Curtiss, Crocker-Wheeler, and Waterhouse electric systems; and we have no doubt in due course that Mr. Gwynne will financially handle the above valuable group of inventions in the manner they deserve to be developed in the European markets, and this probably without the assistance or intervention of the firm alluded to.

Knowing that your journal has a known reputation for inserting authentic information, and that it also aims in carrying out as far as possible *your well-known motto* for correspondents, we will thank you to insert this letter in your next issue, and by so doing you will oblige.—Yours, etc.,

Shippey Brothers, Limited,
(Per William B. Hammond.)

13 and 14, Cheapside, E.C., Dec. 17, 1891.

UNDERGROUND LIGHTING MAINS IN PARIS.*

BY E. DIEUDONNÉ.

(Concluded from page 512.)

Mains of the Compagnie de la Place Clichy.—The system of mains adopted by this company is essentially different in many ways from all the others laid in Paris. Here there are no conduits—of cast iron, concrete, earthenware—and no bare cables. The cables are all heavily insulated, and simply laid at the bottom of a trench under the pavement on a layer of sand. [It is perhaps as well for English readers to note that the subsoil of Paris is of an entirely different nature to that usually experienced in the damp soil of London, consisting usually of light, dry, stony earth, like crushed stone.] The laying of the cables becomes in this case a very rapid operation, the time of interfering with the pathway is considerably diminished as compared with the time required for the other systems described. To open the trench, lay the cables, and fill up again quickly, are the three phases of this system. The junctions and connections are made, under a portable shelter, in cast-iron boxes, as afterwards described.

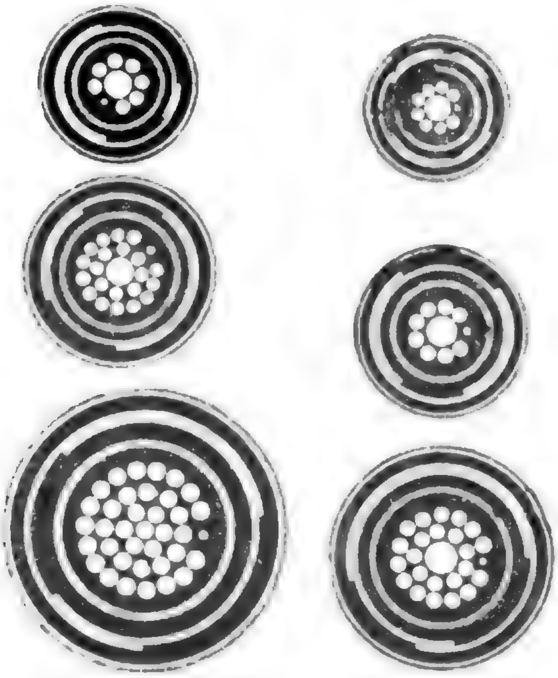


Fig. 57.

The cables employed by the Compagnie de la Place Clichy are of the Siemens type, manufactured at Belfort by the Société Alsacienne de Constructions Mécaniques. The author of these articles had the good fortune to see the manufacture of this class of electric cables at the works of Messrs. Siemens themselves at Charlottenberg, near Berlin. The process of insulation is extremely carefully carried out, and the insulated cables are covered with lead. They are classed ordinarily into four different types, corresponding to various inherent requirements of employment combined with economy:

(*a*) Conductors with lead sheath, unprotected with exterior envelope.

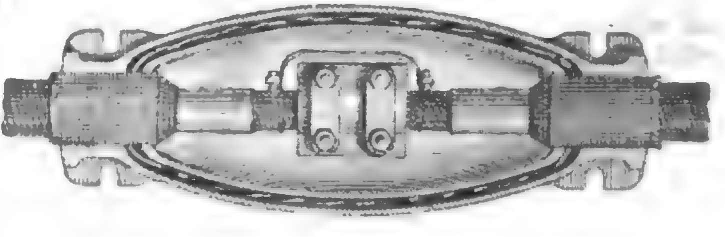
(*b*) Conductors with lead sheath, covered with a serving of asphalted jute.

(*c*) Conductors with lead sheath, covered with layer of insulation, again wrapped by two iron strips wound spirally and simultaneously around the cable, Fig. 57. The whole is finally covered with tarred jute.

(*d*) Lastly, those in which the external wrapping is of iron wire.

Among these four types of cable the mains engineer will exercise a judicious selection. When the section of the conductor does not exceed 30 square mm., a single copper wire is used; for larger sections the core is formed of stranded wires. The insulation is composed of a serving of cotton or jute, highly dessicated in vacuum, and then impregnated with an insulating compound the description of which is not divulged. The proprietors of the process affirm its superiority to indiarubber, guttapercha, and similar materials, a claim which must so far remain for us a simple allegation. The thickness of this insulation depends upon the voltage it is to withstand. Amongst the strands forming the cable is an insulated strand of smaller section, which acts as a pilot wire to measure the difference of potential at the extremity of the cable.

Fig. 58.



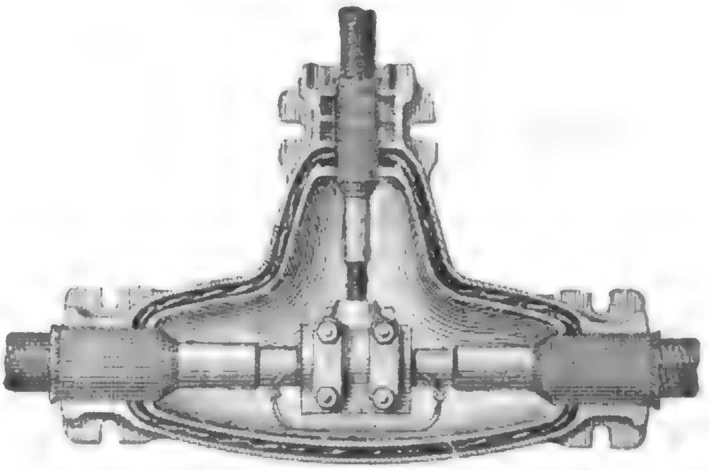


Fig. 60.

These mains, although sufficiently armoured with their iron sheathing, when laid in their trenches and covered with a layer of sand are, nevertheless, liable to various eventualities; such as a violent stroke from a pickaxe, if there is nothing to call the attention of the labourer to their presence in the ground. It is thought sufficient generally to lay over the trench, just below the pavement, a galvanised iron wire meshing, which would serve to attract the attention of any workman taking up the flags. In many cases this would appear insufficient. Occasionally it would be better instead of the metallic meshing, to use creosoted deal boards. When passing under the roadway the cables are threaded through iron pipes.

The distribution in the district of the Place Clichy is on the five-wire system, supplied by one or several groups of dynamos connected in parallel, giving the requisite pressure between the exterior conductors. Two feeders are therefore all that are required to connect the exterior conductors with the dynamos. The lamps are distributed judiciously on the four bridges formed by the intermediary conductors.

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* From *L'Electricien.*

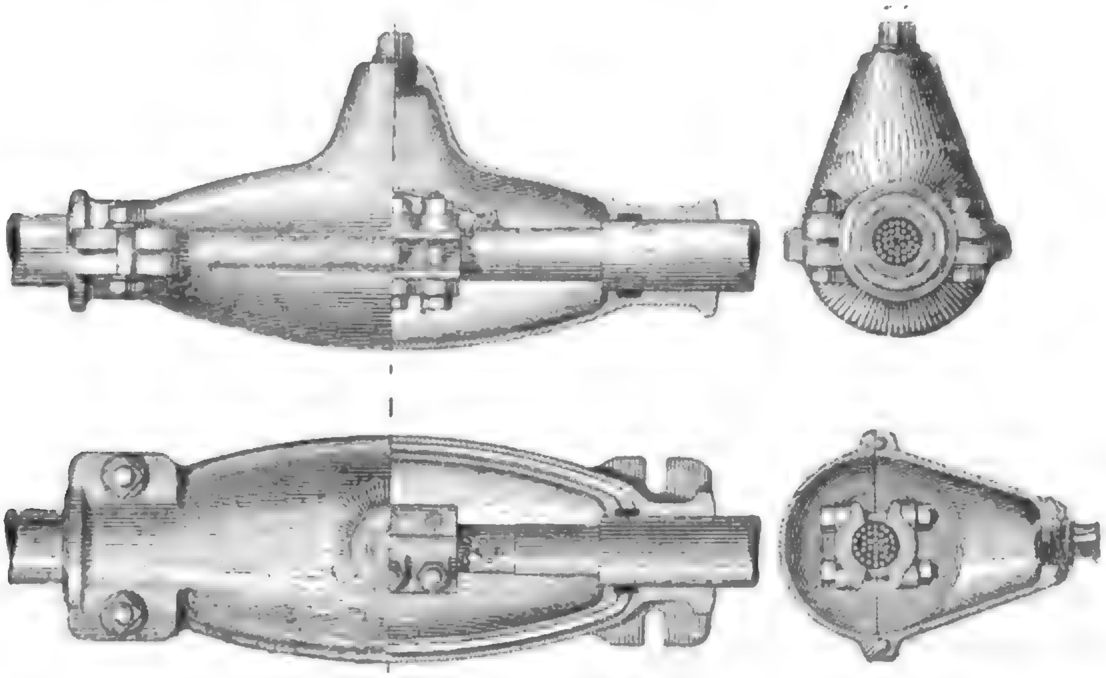

Fig. 59.

It follows that the number of cables to be laid in the trench will be usually five, and sometimes seven when the feeders follow the course of the distributing mains. The cables are distinguished by means of small metallic clips, placed upon them at short intervals.

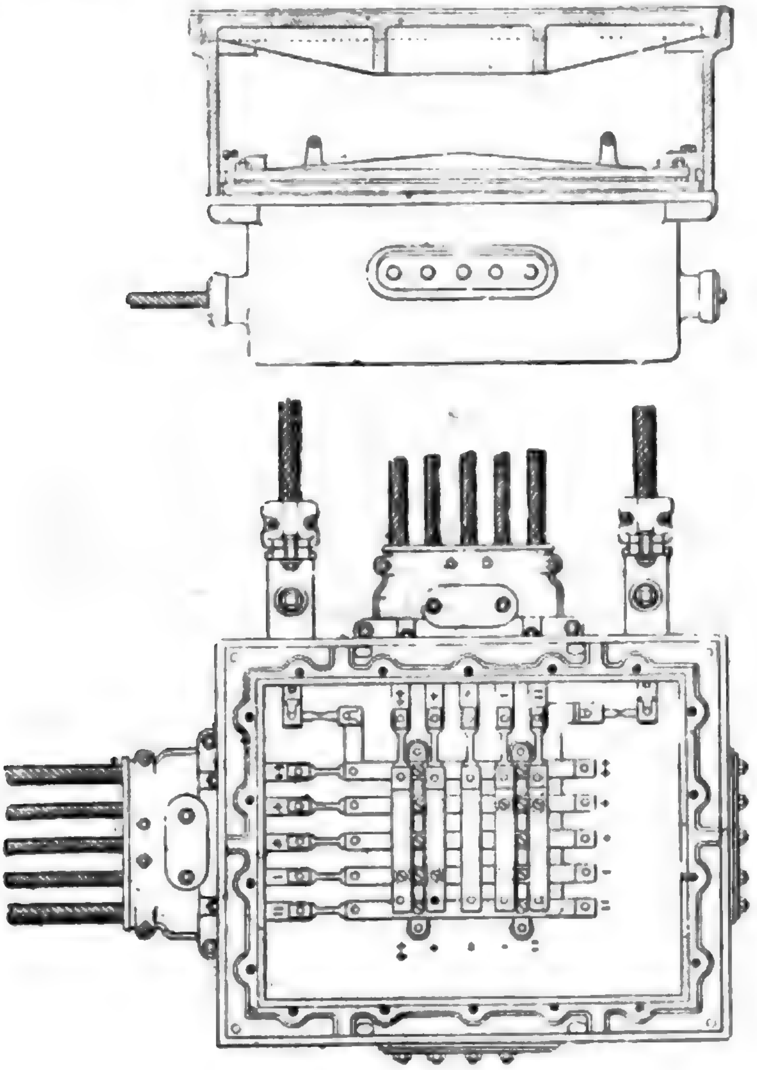

Fig. 61.

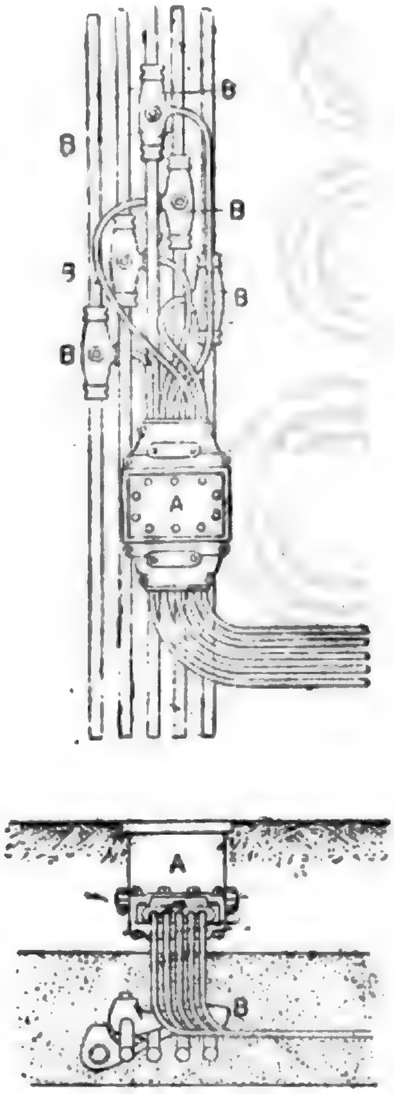

Fig. 62.

These mains have a high insulation resistance; the only places which would give any cause for trouble are the points of junction of cable to cable or of service mains. In laying new mains the greatest possible precaution is therefore taken. The end of a cable is never left bare; as soon as it is prepared for junction, it is inserted in a sleeve and buried in a mass of insulating material.

Simple junctions are made in junction-boxes cast in two pieces, see Figs. 58 and 59, having stuffing-boxes for tightly gripping the cable and preventing the intrusion of moisture. The two cores are butted and tightly screwed between two solid copper sleeves. The pilot wires are separately joined. After the junction-box is bolted up, it is filled with melted insulation through a hole in the cover. The junctions of the copper are not soldered.

Fig. 60 shows a tee junction-box based upon the same method of connection.

At points where the conductors ramify, distributing-boxes are installed of the type of those shown in Fig. 61, which gives the example of a right-angle connection with the addition of two feeders. These are made of cast iron, with hermetically sealed covers; junction-pieces connect the cables which come into the box through lateral stuffing-boxes, at which point the cables are bared. The end of the cable is fitted into a socket fixed by pointed set screws; and the whole is covered with an indiarubber sheath. The space left free around the cable is filled up with insulating material, poured in at several times to allow for contraction

The centre of the box is occupied by metallic bars by which any cable can be put into communication with any other. Cut-outs are inserted between the mains and these bars. The cover itself of the box is surmounted by a further hollow and elevated lid, the upper surface of which is level with the footpath.

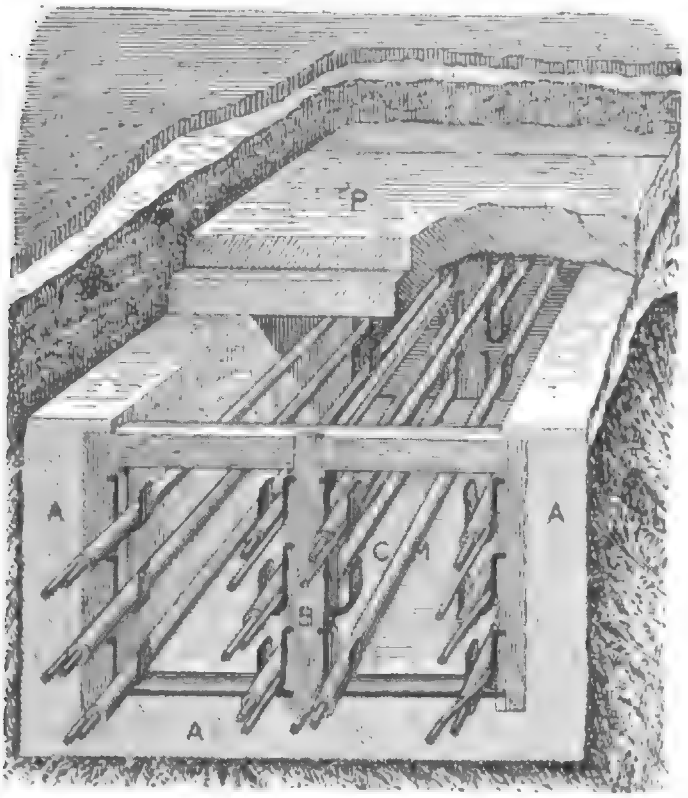

Fig. 63.

Fig. 62 shows both the arrangement of tee junction-boxes, and the distributing-box to which the house service mains are connected. There are several different types of junction-boxes, the form varying according to requirements; but the system of construction and laying of the mains is always based upon the same general method.

The Company of the Place Clichy, while confident of the good insulation of its armoured cables, has multiplied its precautionary measures at those points at which leakages and faults mostly occur in underground mains—namely, at the junctions and branchings—so as to thoroughly assure the necessary safety of working.

Municipal Station of the Halles Centrales.—The technical commission which directed the erection of the Paris municipal station at the Central Markets, decided to use both continuous currents and alternate currents with transformers. According to the choice of one or of the other system, the mains used have been varied. They will therefore be here considered separately.

The distribution of the continuous current in the market and the neighbouring streets is carried out by means of the three-wire system and feeders. The difference of potential between the extreme wires does not exceed 220 volts.

Within the markets none of the mains are underground except the feeders; the distributing cables are run along the walls of the stalls, protected by wood casing.

The cables are carried in concrete conduits 45 cm. (17in.) wide and 30 cm. (11in.) deep, Fig. 63, on wood frames, B, which are furnished with enamelled metallic hooks. These double frames are embedded in the concrete at distances of about one metre. The culvert is closed by slabs of the same material, the joints filled up with loam, after which the path is relaid above them. As in the other systems already described, the crossing of the streets is carried out by vaulted galleries ending in vertical manholes.

The high-tension mains in which alternating currents of 2,400 volts are carried, are also placed in concrete conduits, but instead of being supported by hooks, they are run in wood casing in order to avoid all accidental contact. Fig. 63 shows the position of the cables.

The specification of these will be of interest and is herewith given as follows:

1. *Low-Tension Mains.*—Metallic core of tinned copper, a layer of pure indiarubber, a layer of mixed indiarubber 2 mm. thick; two ribbons of indiarubber tape, vulcanised; a serving of bitumenised braid.

2. *High-Tension Mains.*—Metallic core of tinned copper; two layers of pure indiarubber 1 mm. thick; several layers of mixed indiarubber of 4 mm. thick; a layer of resinous hemp 3 mm. thick; two ribbons of cotton tape.

The only difference between the two cables is in the thickness of insulation, as seen in Fig. 64. The insulation required by the specification was 300 megohms per kilometre (about 190 per mile) for the low-tension, and 8,000 megohms per kilometre (about 5,000 per mile) for the high-tension cables at 24deg. C.

Along a portion of the route the high-tension main, passing near the telephone wires, it has been necessary to avoid induction noises by employing concentric cables.

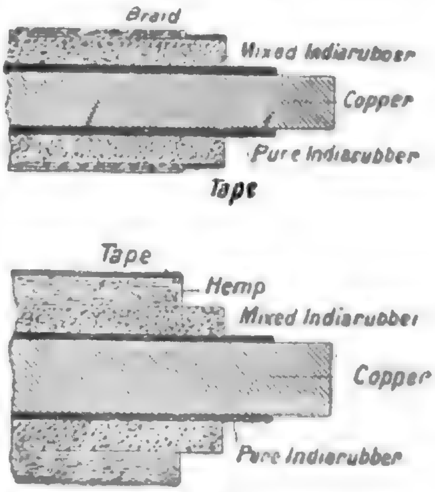

Fig. 64.

We have thus given, in the course of a somewhat extended review, with abundance of illustrations, and in as short and direct manner as possible, the various systems of underground mains adopted by the electric light companies of Paris. Which system will prove in all respects the best, time alone can be trusted to decide.

THE MEASUREMENT OF THE RESISTANCE OF CONDUCTORS CONTAINING DISTURBING E.M.F.'S.*

BY ROLLO APPLEYARD.

The principal practical case in which we have a conductor containing a disturbing E.M.F. is a telegraphic circuit terminating in earth-plates. These earth-plates, from various causes, act as a battery, and the resistance of the line appears too small or too great, depending on the direction of the natural currents with respect to the working current. In order that the position of a fault may be accurately found, it is desirable to know the resistance of the earth-plates and the value of the natural E.M.F. As it was with earth-plates that my first experiments were made, I propose in this paper to give you the results obtained with them in full. For the sake of clearness, it has been found necessary to refer to much that is elementary. In this I must ask for your kind indulgence.

Let us first be sure of what we mean by the resistance of an earth-plate. Taken alone, the term does not quite explain itself.

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* Paper read before the City and Guilds Old Students' Association.

Schwendler ("Testing Instructions," vol. ii.) defines it as the resistance offered by our planet between the earth-plate and another earth-plate of very great size, situated at a very great distance. It is there also shown that if we accept this definition we are justified in assuming the resistance between any two earth-plates as equal to the sum of their respective resistances.

If then we are given three earth-plates of unknown resistances, x, y, and z, it is possible, by connecting them in pairs, to find their individual resistances. Let

$$x + y = a, \qquad y + z = b, \qquad z + x = c,$$

where a, b, and c are the resistances of the plates taken in pairs and measured by any of the "earth-to-earth" systems. Then

$$x = \frac{a+b+c}{2} - b, \qquad y = \frac{a+b+c}{2} - c, \qquad z = \frac{a+b+c}{2} - a.$$

The traditional method for the finding of a, b, and c is similar to the one adopted for measuring the resistance of cells by a tangent galvanometer. It has to be modified, however, to allow for the disturbing E.M.F. of the plates themselves. Let E be the E.M.F. of the testing cell, and B its internal resistance; G the galvanometer resistance, and θ_0, θ_1, the deflections corresponding to added resistances, R_0 and R_1. We have

$$E = \tan\theta_0\,(G + B + R_0) \quad . \quad . \quad . \quad . \quad . \quad (1)$$
$$E = \tan\theta_1\,(G + B + R_1)$$

Hence $$G + B = \frac{R_1 \tan\theta_1 - R_0 \tan\theta_0}{\tan\theta_0 - \tan\theta_1}$$

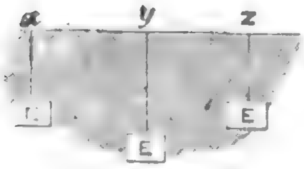

FIG. 1.

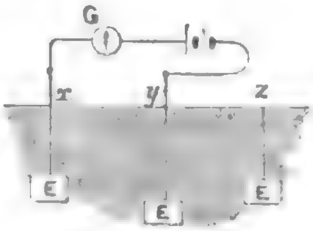

FIG. 2.

Now, in place of R_0, R_1, put the leads from the earth-plate, x and y, Fig. 2. The disturbing E.M.F. is acting at first, suppose, in the same sense as E. Let it be e: then

$$E + e = \tan\theta_{11}\,(G + B + x + y) \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Now reverse the testing battery so that e opposes E: then

$$E - e = \tan\theta_{111}\,(G + B + x + y) \quad . \quad . \quad . \quad . \quad (3)$$

From (2) and (3) we have

$$E = \frac{\tan\theta_{11} + \tan\theta_{111}}{2}\,(G + B + x + y) \quad . \quad . \quad . \quad (4)$$

From (1) and (4)

$$x + y = \frac{\tan\theta_0\,(G + B + R_0)}{\dfrac{\tan\theta_{11} + \tan\theta_{111}}{2}} - (G + B)$$

This gives us a. The values of b and c are similarly arrived at, and these results are said to give the earth-plate resistances.

A series of tests was made by this method with three "earths," of which x was the resistance of the gas-pipes at the place in question; y, an earth-plate to a lightning conductor; and z, a copper earth-plate of ordinary type. The following values for the individual resistances were obtained at different times within a few weeks.

TABLE I.

x	y	z
·83	3·33	24·85
- ·2	6·3	22·7
- 1·2	4·3	33·1
·3	6·3	21·2
·12	4·98	19·69
-2·4	5·9	23·4
0·05	4·45	23·15
- 1·07	5·01	22·24
- ·06	4·77	21·7
-·16	4·34	20·09

Schwendler's tangent galvanometer, as made for the Indian telegraphic department, was employed, with two Minotto cells connected in parallel.

The absurdity of resistance with a negative sign should sufficiently show the fallacy of this method; and it will appear the more inconsistent when I refer you presently to results which make the resistances nearly constant throughout the same period of time. The variations are not due, as is generally assumed, to changes in the actual resistance of the plates themselves, but to the faulty method. We cannot take it for granted that the E.M.F.'s remain unchanged when the circuits are once completed. e in equations (3) and (4) is not constant.

The second experiments were made with Wheatstone's bridge in its usual form. The difficulty was precisely the same. The E.M.F.'s in the "unknown" arm of the bridge run themselves down through the other branches. The accuracy depends here, as before, upon e keeping constant.

The results were, if anything, rather worse than by the tangent galvanometer, the smallest resistance nearly always appearing with a negative sign. The wonder is that such methods still find a place in manuals on telegraphy. Schwendler's book suggests that these tests are best carried out on Sunday. The fact that mine were made on all days of the week may explain their inconsistency.

If a nearer approach to accuracy was to be obtained it became evident that a means must be found for diminishing, as far as possible, the time during which the plates are on circuit at the bridge. The following method suggested itself:

Let m, n, p, q, represent the four corners of the bridge; a and b the ratio arms; d the variable resistance; and x the unknown resistance which contains the disturbing E.M.F. At q, the meeting point of the battery branch with x and d, separate the three branches, and bring a connection from each to the upper three springs of a five-contact key. The lower springs, insulated from the three above, are for the completion of the galvanometer circuit. The conductor whose resistance is to be determined is at present on open circuit. Now adjust the arm, d, to some assumed value of x, and verify it by a single tap of the key. The E.M.F. in the x branch cannot appreciably vary during that short interval, and by a few trials the correct value of d is determined. The testing battery is now reversed, and a new value, d^1, obtained for the variable arm. For general purposes, it will be found sufficiently accurate to take the mean of d and d^1 as the required resistance of x. If the disturbing E.M.F., however, is high, we must use the whole formula for the resistance of the bridge arm and make the necessary correction. In this case let

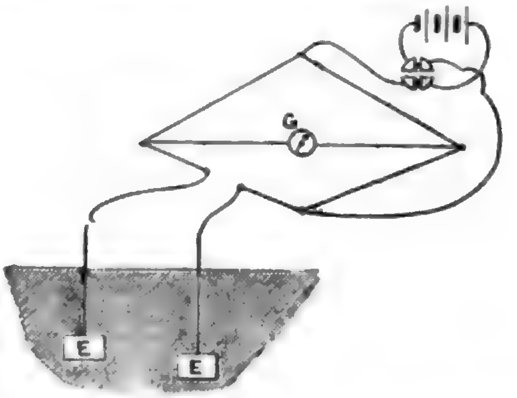

FIG. 3.

E = E.M.F. of testing battery.
e = E.M.F. in the x branch.
a, b, d, x, f, g = the resistance in the six branches.
A, B, D, X, F, G = the corresponding currents in a, b, d, x, f, g.

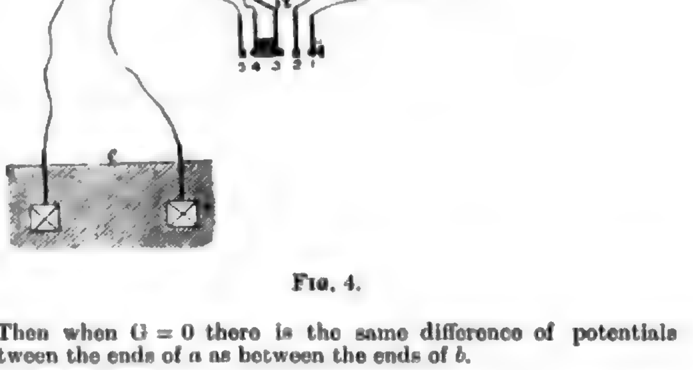

FIG. 4.

Then when G = 0 there is the same difference of potentials between the ends of a as between the ends of b.

$$\therefore \frac{A}{B} = \frac{b}{a} \qquad B = A\,\frac{a}{b} \quad . \quad . \quad . \quad . \quad (1)$$

Considering point m, X = A . . . . (2)

" " n, $D = B \therefore D = A\,\dfrac{a}{b}$ . . . . . (3)

" " p, $F = A + B \therefore F = A\,\dfrac{a+b}{b}$ . . . (4)

In the circuit m, q, n, m, we have

$$e = \mathrm{X}\,x - \mathrm{D}\,d \therefore e = \mathrm{A}\left(x - \frac{a\,d}{b}\right) \quad . \quad . \quad . \quad (5)$$

In the circuit q, p, n, q, we have

$$\mathrm{E} = \mathrm{F}f + \mathrm{B}\,b + \mathrm{D}\,d = \mathrm{A}\,\frac{a+b}{b}f + \mathrm{A}\,\frac{a}{b}\,b + \mathrm{A}\frac{a}{b}\,d$$

$$= \frac{\mathrm{A}}{b}\,([a+b]f + a\,b + a\,d]) . \quad . \quad . \quad . \quad (6)$$

From (5) and (6)

$$\frac{e}{\mathrm{E}} = \frac{b\,x - a\,d}{f(a+b) + a\,b + a\,d} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

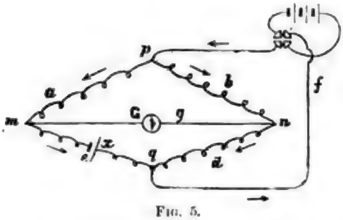

Fig. 5.

Now reverse the testing battery, obtaining $-\mathrm{E}$ for E, and d^1 for d

$$\frac{e}{\mathrm{E}} = \frac{-\,b\,x + a\,d^1}{f\,(a+b) + a\,b + a\,d^1} \quad . \quad . \quad . \quad . \quad (8)$$

Add numerators and denominators, respectively of (7) and (8),

$$\therefore \frac{e}{\mathrm{E}} = \frac{a\,(d^1 - d)}{2f\,(a+b) + 2\,a\,b + a\,(d^1 + d)} \quad . \quad . \quad . \quad (9)$$

Subtract ditto,

$$\frac{e}{\mathrm{E}} = \frac{2\,b\,x - a\,(d^1 + d)}{a\,(d - d^1)} . \quad . \quad . \quad . \quad . \quad (10)$$

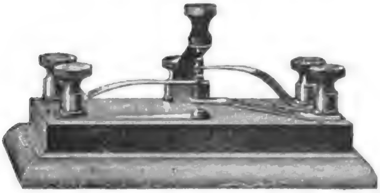

Fig. 6.

By equating (9) and (10) we have

$$x = \frac{a\,(d^1 + d)}{2\,b} - \frac{a^2\,(d^1 - d)^2}{2\,b\,(2f\,[a+b] + 2\,a\,b + a\,[d^1 + d])} .$$

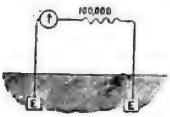

Fig. 7.

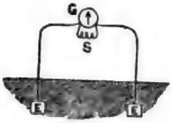

Fig. 8.

For practical purposes this complete formula need be applied only in extreme cases. Using the simple relation

$$x = \frac{d^1 + d}{2} \cdot \frac{a}{b}$$

the following values were obtained at different times for the resistances of the earth-plates before referred to:

Table II.

Date.	x	y	z
3/6/91	·325	3·83	16·6
"	·330	3·84	16·725
4/6/91	·320	3·945	17·325
"	·348	3·768	17·263
5/6/91	[illegible]	3·875	17·20
[illegible]	[illegible]	3·845	17·545
[illegible]	[illegible]	[illegible]	17·513

Between these tests the plates were used from time to time for signalling work and line testing. It is seen that their resistance varies but very little.

By the formula (9) we are able to find e, the distributing E.M.F., in terms of E, the E.M.F. of the testing battery.

(*To be continued.*)

ELECTRIC LIGHTING OF HOUSES.

At the second ordinary meeting of the Dundee Institute of Architecture, Science, and Art, Mr. F. Grant Ogilvie, principal of Heriot-Watt College, Edinburgh, delivered a lecture on "Electric Lighting of Houses." Mr. Charles Ower (president) occupied the chair. The chairman said the lecture was one of two which had been specially arranged for in connection with the fact that Dundee was setting about introducing the electric light.

Mr. Ogilvie began by referring to the nature of electric light, and detailed some of the principal facts in relation to electricity which would have to be dealt with in its distribution in houses. He explained how the wire, heated by the electric current, gave off light, but at the same time, when made of certain metals, would melt. The lecturer then demonstrated the manner in which an electric lamp gave out light. The filament in the lamp, being made of carbon, glowed when the current was passing through, and during the process particles of carbon were thrown off, and in time the filament became thinner and thinner until it broke. The average life of a lamp was about 1,000 hours burning. The lecturer then explained the uses of the electric battery, and the signification of the electrical terms ampere and volt, which signified the strength of the current and the difference of electric pressure. By means of diagrams shown on the blackboard with coloured chalks, Mr. Ogilvie represented how electricity could be distributed in houses. The two wires were brought into the house, the one being at an electrical pressure of 100 volts above the other. These two wires were connected by another passing through the lamp, which glowed when the electric current was passed. The fittings for the distribution of the electricity were, he said, of importance. The conductor of the electric current was of copper or an alloy of copper, and to prevent electricity escaping from one wire to another, or into the material of the wall, the copper wire was entirely surrounded by some substance which offered great resistance to the flow of electricity. The way in which wires could be carried over a house was then detailed, and the use of the switch for turning on and off the current minutely explained, a switch being handed round among the audience to clearly show how it acted. It was usual also to have a wire not copper which formed part of the circuit, and which was of a substance easily fused. The object of this was to prevent any accident occurring in the event of some unforeseen contact between the two wires. This fusible piece of wire prevented the possibility of such an accident, as should such a mishap come to pass the wire fused and the injured part of the circuit was "cut out." A number of electric lamps suitable for fixing in different positions were exhibited to the audience. These and an exhibit of lead casings and various fittings were lent by the Brush Company. Mr. Ogilvie remarked that it was the exception now to find an ugly electrical fitting. The practical methods of measuring the electric power supplied to a house were explained generally and illustrated by the Shallenberger meter, an example of which was exhibited to those present. The lecturer at the close referred to the cost of electric light, especially as compared with the cost of gas, and by means of calculations demonstrated how the different prices might be arrived at and compared. He showed that under ordinary domestic conditions 1,000 c.p. of gas gave about the same amount of light as 12 Board of Trade units of electricity, so that the pence price of a B.T. unit taken as shillings might be compared directly with the quoted price of gas. To the price of this quantity of electric energy there would have to be added about one-fifth of the price of a lamp, say 9d. This addition, however, might soon be expected to be reduced by one-half. Though gas was at present cheaper than electricity, the waste of the latter was very much less, as more gas was used than was actually required. A switch provided in a convenient place at the door of each room would enable one to turn the electric light on or off as desired. The great qualification of electric light, however, as compared with gas, was that it did not in any way alter the chemical condition of the air. Electricity heated the air, but did not burn it or vitiate it in any way, and the vitiation of the air by gas was one of the main items to be put in the balance against the additional price of electric lighting.

A number of questions were then asked by various members, and answered by the lecturer.

On the motion of Mr. F. W. YOUNG, seconded by ex-Bailie M'CULLOCH, a hearty vote of thanks was awarded to Mr. Ogilvie, and a similar compliment having been paid to the chairman the proceedings terminated.

ELECTRIC VEHICLES.

The question of introducing a commercially successful electric vehicle for use on common roads has long engaged the attention of electrical engineers in different countries. Two Italians claim to have succeeded where others have failed—the one by the employment of accumulators, and the other by the use of primary batteries. The first is a three-wheeled vehicle, made in the Castelnuovo Works of Garfagnana, on the Boggio system. Its total weight, excluding passengers, is said to be only 2¾cwt. It is 6ft. long, 3ft. 4in. wide, and 4ft. in height, and can carry two passengers. There are 10 accumulator cells which, it is claimed, have as high a capacity as 25 ampere-hours per kilogramme of plate. These cells are, according to the Italian journal *L'Industria*, encased in an ebonite box. When in operation, and with a discharge of 12 amperes, the charge will last 10 hours. The motor absorbs 942 watts, and is stated to run at 3,000 revolutions per minute !

The second type of carriage has been devised by Mr. Malignani, the director of the well-known Udine electric light station According to Mr. Ferrucci, Mr. Malignani has invented a "special" kind of primary battery having a maximum of simplicity, and practically solving the problem of electric locomotion on common roads. No particulars are, however, given concerning the construction of the battery, but its efficiency is said to be very high. The Malignani electric carriage is built to accommodate three persons, and is constructed so that the dead-weight has been reduced to a minimum.

SPECIFICATION

FOR ESTABLISHING AN ELECTRIC LIGHTING INSTALLATION ON THE LOW-TENSION SYSTEM WITH UNDERGROUND CABLES FOR THE CORPORATION OF NELSON.

Situation.—The central station to be at the gas works, where an engine-room and all foundations, steam and exhaust pipes, will be provided by the Corporation, also a supply of steam at 80lb. pressure.

Steam Engine and Dynamo.—The contractor to supply and erect at the gas works a steam engine and dynamo capable of supplying 600 lights of 16 c.p. each, requiring a pressure of 110 volts. The dynamo to be self-regulating, and the armature shaft to be coupled direct to the crankshaft of the engine, the engine and dynamo to be fixed on to one strong cast-iron bed-plate, the speed of the engine not to exceed 400 revolutions per minute, and the dynamo giving an output of 360 amperes.

Switchboard.—To supply a main switchboard in the dynamo-house, with main switch, variable shunt resistance for dynamo, ammeter, and five voltmeters placed upon it (four voltmeters for pressure wires and one for dynamo terminals).

Cables—Main Feeder No. 1.—800 yards of stranded copper cable composed of 61 wires, each 12s standard B.W.G.; the wires to be covered with pure vulcanised indiarubber, the insulation resistance to be 600 megohms per statute mile, tested under water, and the drop of E.M.F. per 100 yards, carrying 50 amperes, not to exceed 0·48 volt.

Cables—Main Feeder No. 2.—950 yards of stranded copper cable composed of 37 wires, each 12s standard B.W.G.; the wires to be covered with pure vulcanised indiarubber, the insulation resistance to be 600 megohms per statute mile, tested under water, and the drop of E.M.F. per 100 yards, carrying 50 amperes, not to exceed 0·78 volt.

Distributing Mains.—1,350 yards of stranded copper cable composed of 19 wires, each 12s standard B.W.G. ; the wires to be covered with pure vulcanised indiarubber, the insulation resistance to be 600 megohms per statute mile, tested under water, and the drop of E.M.F. per 100 yards, carrying 50 amperes, not to exceed 2·00 volts.

Service Mains.—500 yards of stranded copper cable composed of 19 wires each, 16s standard B.W.G. ; the wires to be insulated with pure vulcanised indiarubber, the insulation resistance to be 600 megohms per statute mile tested under water.

Pressure Wires.—5,000 yards of copper wire No. 14s standard B.W.G., covered with pure vulcanised indiarubber ; the insulation resistance to be 600 megohms per statute mile, tested under water.

Quality of Copper.—All the stranded copper cables and pressure wire to be composed of and guaranteed from the maker 98 per cent. pure copper. A sample 6in. long of all sizes of cables and pressure wires tendered for must accompany tender or disqualified.

Tapping-Bars.—40 tapping-bars made as per plans and specification, the length of each bar to be 12¼in. by 1¾in. broad by ⅜in. thick, with an angle-piece at one end same thickness and breadth as the bars ; 40 small flat plates 3¼in. long by 1¾in. broad by ⅜in. thick, bolted to one end of copper bars with ¼in. brass bolts and nuts, the shoulder of bolts to be turned true and to fit the holes tight and accurately, holes to be prepared in the latter-named plates to receive ends of cables, which must be sweated on with solder as shown on plan ; 40 small angle plates 3¼in. by 3in. by 1¾in. broad and ⅜in. thickness of metal, bolted to tapping-bars with two ¼in brass bolts and nuts, the shoulders of bolts to be turned true and to fit the holes tight and accurately, holes to be prepared to receive ends of cables. which must be sweated on with solder.

Junction-Plates.—12 T junction-plates and two large circular junction-plates ⅜ of an inch thickness of metal fitted up in the same manner as tapping-bars, with angle-plates ¾in. by 3in. by 1¾in. broad and ⅜ of an inch thickness of metal, but without terminals, ends of cables to be sweated on with solder.

Tapping-Bars, etc.—All the above bars and plates to be guaranteed 98 per cent. pure copper, thoroughly planed and made smooth throughout ; every face must be almost airtight when put together and bolted up. Particular attention must be paid to this part of the installation by the contractor, as the work will have to be done as per plans and specifications, and to the entire satisfaction of the engineer appointed by the Corporation. Two brass terminals must be screwed and fitted accurately to each tapping-bar, the shoulder of each terminal to have a true and level face when fixed in a true position on the bar. The above to be in accordance with the plans and specifications and the sample shown.

Cut-outs.—20 cut-outs, to be composed of a polished slate slab free from all cracks and defects of any kind ; the size of slab to be 15in long, 6in. broad, and ¾in. thick, the slab to contain eight terminals accurately fixed on the slab, which must have a smooth surface The screw holes made in the slab to be filled in with hard wood pegs, so as to receive the 5/16in. screws that fasten down the terminals to the slab. The terminals to be fitted up with a small loose bar that fastens down the fuse-plates, all to be in accordance with the plans and specifications and samples shown.

Service Pipes.—500 yards of wrought-iron service pipes, lined inside with glass tube, and to have a very smooth surface inside the tube. To be supplied in various lengths as the Corporation may require, delivered at Nelson Station.

Cast-Iron Troughs.—1,540 yards of cast-iron troughing in 6ft. lengths, with flanged joints. The castings must be of ⅜in. thick all through, the bolt holes to be ⅝in. square, and those in the top or longitudinal plates or covers must be 6½in. from centre to centre ; two small fillets must be cast vertical on each side of troughs ½in. by ⅜in. at a distance of every 2ft. to receive earthenware insulators. The top plates or covers must be ⅜in. thickness of metal throughout, and the bolt holes to correspond with the bolt holes in the top flanges of troughs when bolted together, as shown on plan. The castings must be of a uniform thickness and free from all cracks, blowholes, sandholes, or any other defects of any kind. All the castings must be straight and smooth. A groove must be cast in the top flange of every trough to receive a ⅜in. round indiarubber band for jointing. All the end flanges must be perfectly square and smooth so as to make a good joint when bolted together with Scotch cement. All the castings to be delivered at the Nelson railway station in a good and sound condition.

Insulators.—3,000 sets of earthenware insulators properly glazed throughout and fixed into slots cast on the inside of cast-iron troughs at a distance of every 2ft., the insulators to act as rests for the cables, which must be laid level and straight throughout the entire length. The insulators must be made to the samples supplied by the Corporation.

Cast Iron Boxes.—20 cast-iron boxes fitted up with cast-iron lid or cover, and fastened down with a wrought-iron cross-bar, with a ⅜in. brass bolt, the lid to have a bead cast on inside to receive a indiarubber band ; the box must be perfectly watertight. The box must be made according to plans, specifications, and pattern supplied ; the thickness of the metal must not be more than ⅜in., and free from all blowholes, sandholes, or defects of any kind. All castings must be delivered in a good and sound condition at the Nelson railway station.

Manhole Covers.—20 manhole covers to be made as per wood pattern supplied by the Corporation, the castings to be free from all blowholes, sandholes, cracks, or defects of any kind. The lid of manhole to fit perfectly level all round, and no warping or twisting to be felt when laid down. The castings to be clean and good, and delivered in a good and sound condition at the Nelson Station

Erection.—The contractor to undertake the sole responsibility of the erection of the installation in every detail, and also undertake the work of fixing the engine and dynamo on foundations prepared by the Corporation, also the laying down of all the main, distributing, and service cables, service pipes, and all other details, according to street plan showing line of wires, connections, and service pipes to consumers, according to plans and specifications supplied by the Corporation engineer. The contractor also to take the entire responsibility of all other minor details not mentioned in the specifications, and to ensure a perfect installation. All the work to be done to the entire satisfaction of the engineer, or some other engineer appointed by the Corporation.

The contractor must guarantee the installation for 12 months, and to take monthly tests in the presence of the engineer, or someone appointed by him, by the Wheatstone's bridge method, handing the certificates of such tests to the Corporation, and the certificate must be duly countersigned.

The Corporation undertake to lay all the cast-iron troughs, junction and tapping boxes, to excavate all the trenches to receive troughs, and all holes for all boxes, and to refill and make good the same.

PHYSICAL SOCIETY.—Dec. 4, 1891.

Prof. W. E. AYRTON, F.R.S., president, in the chair

Messrs. P. L. Gray, A. Anderson, H. Davey, L. W. Fulcher, H. H. Hoffert, and W. Watson were elected members.

A paper on "**A Permanent Magnetic Field**" was read by **Mr. W. Hibbert, A.I.E.E., F.I.C.** The author had noticed the approximate constancy of an "aged" bar magnet, and he obtained still greater constancy by attaching pole-pieces to a bar magnet, of such a shape as to give a nearly closed circuit of small "magnetic resistance." The pattern now described consists of a steel rod 1in. diameter and about 2¼in. long, with a cast iron disc 4in diameter and ⅝in. thick fixed at one end, the other end is fitted in a hemispherical iron shell which surrounds the bar and comes flush with the upper surface of the disc. An annular air space, less than $\frac{1}{16}$in. wide, is left between the cylindrical surface of the disc and the inside of the shell, and when the bar is magnetised a strong magnetic field exists in this space. To use this field for producing electromagnetic impulses, a coil of wire is wound in a shallow groove on a brass tube which can slide axially through the annular space, thus cutting all the lines. The tube is allowed to fall by its own weight, a neat trigger arrangement being provided for effecting its release. The instrument exhibited had 90 turns of wire in the coil, and the total magnetic flux across the air space was about 30,000 C.G.S. lines. A large electromagnetic impulse is therefore obtainable even through resistances as great as 10,000 ohms. Tests of three instruments show that there has been practically no magnetic decay in seven months. The author therefore considers them satisfactory and is prepared to supply them as magnetic standards. To facilitate calculation, the number of lines will be adjusted to a convenient number, say, 20,000 or 25,000. Several uses to which the instruments are well suited are mentioned in the paper, and a simple way of determining permeability by the magnetometer method is described. **Mr. Blakesley** thought the name given to the instrument was inappropriate, for it really gave a constant impulsive E.M.F. **Dr. Sumpner** said the constancy of the sensibility of d'Arsvonal galvanometers was a measure of the constancy of magnets having nearly closed circuits. Such instruments in use at the Central Institution had remained unchanged for several years. **Prof. S. P. Thompson** admired Mr. Hibbert's instrument, and thought it would be very useful in laboratories. Standard cells, he said, were not always reliable, and condensers were the most unsatisfactory of electrical standards. On the subject of permanency of magnets, he said that Strouhal and Barus found that magnets with nearly closed circuits were most constant, and that, to give the best results, the hardness of the steel should be less the more closed the circuit. Mr. Hookham had also found that by using a nearly closed circuit, and reducing the strong magnetisation by about 10 per cent. great constancy could be obtained. Some years ago he (Prof. Thompson) had tried the effect of ill-treatment on magnets, and observed that touching or hitting a magnet with non-magnetic material had little effect, whilst similar treatment with iron or magnets affected them considerably. Suddenly removing the keeper of a magnet tended to increase the magnetism, whilst putting a keeper on suddenly had the reverse effect. Strouhal and Barus had also investigated the temperature coefficient of magnets, and found that this might be reduced by subjecting the magnet to rapid changes of temperature after the first magnetisation and then remagnetising. **Mr. W. Watson** enquired what was the percentage fall in strength of Mr. Hibbert's magnets. The bars used in magnetic surveys had been tested frequently, and they lost about 0·5 per cent. in six months. The **President** asked what was the temperature coefficients of the magnets described in the paper? Mr. Evershed, he said, thought it was between 0·01 and 0·05 per cent. for ordinary magnets. He thought the instrument shown by Mr. Hibbert would be of immense value if the magnet was really permanent. By it ballistic galvanometers could be readily calibrated, and when combined with a resistance-box, it could also be used as a standard for current; for since the constant of a ballistic galvanometer for quantity can be determined from its constant for current, if the periodic time be known, conversely that for current can be found from the constant for quantity. In some instances this would be of great use. Speaking of the temperature coefficient of condensers, he said that in some cases the specific inductive capacity of dielectrics diminished with rise of temperature, whilst in others it increased. **Mr. Hibbert**, in reply, said he found the temperature coefficient of his magnets to be, roughly, about 0·03 per cent., but he had not investigated the matter very carefully. In making his measurements no correction had been made for the variation of capacity of his condenser with temperature.

Mr. Walter Bailey, M.A., took the chair, and the **President** communicated a "**Note on Rotatory Currents.**" The subject, he said, was probably familiar to most persons present, for it had been frequently referred to in the scientific papers. Alternate currents could be obtained from an ordinary direct-current dynamo by making contact with two points in the armature, say, by connecting these points to insulated rings on the shaft, and using extra brushes. A direct-current motor similarly treated transforms direct currents into alternating currents, or into mechanical power. If two pairs of points in the armature be selected, situated at opposite ends of two perpendicular diameters, then two alternating currents differing in phase by 90deg. can be obtained, and by choosing suitable points in the armature two, three, or more currents differing in phase by any desired angles can be produced. In ordinary motors the connections for doing this would be troublesome, but the Ayrton and Perry form, which has a stationary armature, lends itself readily to this purpose, for contact can be made with any part of the armature with great facility. A motor of this kind was exhibited, in which contact was made with four equidistant points on the armature. On connecting opposite points through fine platinum wires, and running the motor slowly, the wires glowed alternately, one being bright whilst the other was dark, and *vice versâ*, thus demonstrating the existence of two currents in quadrature. When the four points on the armature were joined to the four corners of a square of platinum wire the wires became incandescent in succession, the glow appearing to travel round the square, and suggesting the idea of rotatory currents. A Tesla alternating-current motor was also driven by two currents, differing in phase by 90deg., obtained from the armature of the Ayrton and Perry direct-current motor above mentioned. The ease with which currents differing in phase by any amount can be obtained from such a motor, led the author to investigate theoretically the case of two circuits connecting opposite ends of two diameters inclined at any angle, a. Calling the currents in these circuits at any instant A_1 and A_2 he had found that:

$$A_1 = 2 n E_0 \sqrt{\frac{\left(r_2+\rho\frac{\pi}{2}\right)^2+\rho^2\left(\frac{\pi}{2}-a\right)^2-2\left(r_2+\rho\frac{\pi}{2}\right)\rho\left(\frac{\pi}{2}-a\right)\cos a}{\left(r_1+\rho\frac{\pi}{2}\right)\left(r_2+\rho\frac{\pi}{2}\right)-\rho^2\left(\frac{\pi}{2}-a\right)^2}} = \sin(pt+\phi).$$

where n = number of turns on armature per radius, E_0 = maximum E.M.F. per convolution;

ρ = resistance of armature per radius, p = angular velocity of rotation;

r_1 = resistance of external circuit in which current A_1 passes;

r_2 = resistance of external circuit in which current A_2 passes;

and
$$\tan\phi = -\frac{\rho\left(\frac{\pi}{2}-a\right)\sin a}{r_2+\rho\frac{\pi}{2}-\rho\left(\frac{\pi}{2}-a\right)\cos a}.$$

A similar expression in which r_1 is written for r_2, and r_2 for r_1, gives the value of A_2. The phase-angle between the currents is given by

$$\tan(\phi+\psi) = \frac{\left(r_1+\rho\frac{\pi}{2}\right)\left(r_2+\rho\frac{\pi}{2}\right)-\rho^2\left(\frac{\pi}{2}-a\right)^2}{\left(r_1+\rho\frac{\pi}{2}\right)\left(r_2+\rho\frac{\pi}{2}\right)+\rho^2\left(\frac{\pi}{2}-a\right)^2-\rho\left(\frac{\pi}{2}-a\right)\frac{\left(r_1+\rho\frac{\pi}{2}\right)}{\cos a}} = \tan a$$

The expression for ϕ shows that the phase of the current in circuit A_1 is independent of the resistance r_1; on the other hand, varying r_2 alters ϕ. It was also pointed out than $\tan(\phi+\psi)$ is generally greater than $\tan a$.

LEGAL INTELLIGENCE.

THE EDISON AND SWAN UNITED ELECTRIC LIGHT COMPANY AND THE EDISON ELECTRIC LIGHT COMPANY v. HAMILTON AND ANOTHER.

Lamp Patent Case.

This case came before Mr. Justice Matthew, in the Chancery Division of the High Court of Justice recently. The plaintiffs, as owners of patents for an invention of improvements in electric lamps, also of the Cheesbrough patent for an improvement in the preparation of the filaments used in the lamps, brought this action to restrain by injunction during the continuance of the letters patent, the defendants, W. J. L. Hamilton and J. C. Roxburgh, of 4B, Newland-terrace, Kensington, from manufacturing, selling, letting, on hire, supplying, or using any electric lamps manufactured according to or in the manner described in the specifications filed in pursuance of the plaintiffs' letters patent, and generally from infringing the plaintiffs' rights in respect of such letters patent.

Mr. Bremner, who appeared for the plaintiffs, said the defendant had put in a defence, but did not appear to defend the action. The plaintiffs' patents had been twice upheld by the Court of Appeal, and therefore the sole question was one of infringement. He would call evidence to show that the incandescent electric lamps sold by the defendants consisted of a glass receiver, two platinum leading wires sealed through the glass, and attached to a carbon filament, which was a distinct infringement of the plaintiffs' patents. The carbon filament was prepared according to the Cheesbrough process, which also was an infringement of plaintiffs' patent rights.

Formal evidence was called which bore out the opening statement of counsel.

Mr. Bremner waived an enquiry as to damages.

Mr. Justice Matthew granted an injunction as prayed, and delivery up of all infringing lamps, with costs.

COMPANIES' MEETINGS.

OXFORD ELECTRIC COMPANY, LIMITED.

On Saturday, the 12th inst., the first ordinary meeting of this Company was held at the offices, 45, Broad-street, Oxford, Mr. J. Irving Courtenay, chairman of the Company, presiding.

The notice convening the meeting having been read,

The **Chairman** said: This is a formal meeting of the Company, called in compliance with the statute within four months from the incorporation of the Company, and is commonly known as the statutory meeting. There are no accounts to be presented, but the Directors gladly embrace the opportunity thus afforded of explaining the position of the Company, and inviting enquiry and co-operation from the shareholders and others attending the meeting. The Electric Installation and Maintenance Company obtained a provisional order, which was confirmed by Parliament on the 4th of August, 1890, under which that company has powers to supply electricity to the whole borough of Oxford. The Directors being desirous of establishing the business as a local enterprise, have made arrangements for transferring the parliamentary powers to the Oxford Electric Company, Limited, and the necessary formalities are being carried out for obtaining the consent of the Board of Trade and the Corporation of Oxford to the grant of a provisional order for the purpose. In the meantime, the Oxford Company, having been duly constituted, entered into a contract with the Electric Construction Corporation, of London and Wolverhampton, by which the Oxford Company purchases all the rights under the provisional order, and provides for the construction of a fully-equipped generating station for the supply of electricity, together with all necessary street works, mains, transformers, and storage batteries, for the supply of an important area which it is first proposed to deal with. This area comprises High-street, Cornmarket-street, Broad-street, Magdalen-street (from the corner of Beaumont-street to Cornmarket-street), and Catherine-street. The area in question, bounded by the streets named, comprises 12 colleges, 39 public buildings and churches, nine hotels, and 337 shops, offices, and private houses. Provision is made in the contract for a supply of electricity sufficient for about 15,000 lamps actually connected with the Company's mains. The contract provides for the purchase of the lease of the land at Osney, formerly known as Cannon Wharf; the construction of the building, of which drawings may be seen on the walls; the generating and distributing plant; the cost of incorporating this Company and obtaining a transfer of the provisional order; a supply of lamps, wire, fittings, etc., to the value of £500; and a sum of £1,500 for the ordinary expenses of the Company. In the contract, the deposit of £1,500 as security paid to the Board of Trade is also provided for, but will be repaid to the contractors on satisfaction of the provisions of the order. Under this contract an agreement has been made for the erection of the generating station with Mr. Kingerlee, the well-known local builder and contractor, who is pushing on the work vigorously, and expects to have all completed by March. During the construction of the building the mains will be laid throughout the compulsory area, so that a supply of electricity will be furnished with all possible speed. The consideration for all these works and payments, including the provisional order, is a sum of £50,500, payable in fully paid-up shares of the Company. Assuming the capital expenditure to be £50,000, the commercial result of the enterprise may be estimated as follows:

Revenue—258,750 units of electricity at 8d., and rent of meters	£8,775	0	0
Expenditure—Running expenses, rent, salaries, insurance, etc.	5,200	0	0
Net income (or 7 per cent. on £50,000)	£3,575	0	0

The extension of the Company's business to the residential district north of the city and the other important parts of the borough outside the area comprised in the above calculations, should materially add to the dividends of the Company, as the capital of £50,000 includes buildings, street works, etc., capable of providing for a larger business. The cost to the consumer at 8d. per Board of Trade unit is equal to about ¼d. per lamp per hour, or, in other words, the current necessary to supply 30 10-c.p. lamps for one hour or their equivalent for a proportionate time. Owing to the facilities for economising the use of electricity, by the provision of a sufficient number of switches judiciously placed in the consumer's premises, it is found by experience that though the relative cost of electricity at 8d. per unit, as compared with gas at 3s. per 1,000 cubic feet, appears to be higher, yet in actual practice the amount paid by the householder in each case would not materially differ, but when the convenience and advantages of the electric light and its indirect economies, such as the saving in renewals of decorations and cleaning of rooms, are taken into account, it is really in the long run cheaper than gas. For a city like Oxford the electric light is almost a necessity. The experience already obtained at the South Kensington Museum and the British Museum proves the value of electricity as a means of illumination for such institutions, while the absolute safety of the method of supply adopted by this Company makes it specially suitable for lighting the various colleges, museums, and public buildings in the city with their priceless contents. I think a few words of explanation are necessary as to the system of electrical supply. I do not propose, however, to go into details, which have been already published, and Mr. Thomas Parker, the chief engineer of the Electrical Construction Corporation, who has designed and is carrying out the installation, is here to-day, and will be ready to give any detailed explanation that may be required. The system proposed may be described as a moderate high-tension continuous-current of 1,000 volts, with continuous-current transformers to convert to 100 volts, and secondary batteries to supply current to the lamps during the hours of minimum supply, thus allowing the generating station to be shut down entirely. The high-tension continuous current will be conveyed by underground mains, which never come in contact with the houses of the consumers, the current delivered to the consumers being absolutely safe, steady, and its continuity secured by the use of the storage batteries. Reliable meters will be supplied to each customer, and charged for by quarterly rental, as in the existing system of gas supply. The cost of fitting premises for the electric light varies with the character of the buildings and the nature of the fittings, which may be of a simple and inexpensive character, or costly designs, according to the taste of the customers. The Company have already been estimating for a few buildings in this city, which may be taken as typical, and comprise:

Clarendon Press	994	16-c.p. lamps	£1,326	1	8
Magdalen College	675	do.	1,433	18	0
Christ Church	595	do.	1,190	0	0
Metropolitan Bank	45	do.	67	10	0
Young Men's Christian Association	62	do.	86	10	0

The wiring and fitting of ordinary premises, such as dwelling-houses, shops, and hotels, with simple fittings, can be very well done at the cost of 30s. per lamp; factories and similar buildings at somewhat less; colleges, museums, and similar institutions according to the condition and character of the buildings. All work of this kind is done under stringent rules framed by the fire insurance companies, and controlled also by the provisions for safety contained in the provisional order. No other method of artificial illumination can be compared with it for freedom from risk of fire, providing you have suitable fittings and a system of supply such as has been sketched out for the supply of the city of Oxford. As I have already stated, the Company has made its arrangements to carry out all the necessary works without any public issue of capital, but the intention is, when the preliminary work is completed, to give the public an opportunity of subscribing to the capital, and thus the inhabitants of Oxford will be able to acquire an interest in this important local enterprise.

Mr. T. Parker explained matters of detail connected with the proposed system of supply, and incidentally mentioned that Sir William Thomson and Prof. Silvanus Thompson had both recently inspected the electrical plant prepared for this installation and that at Sydenham, and highly approved of the working of the continuous-current transformers, Sir William Thomson having expressed the opinion that their success would lead to the alternating-current system being eventually superseded.

A strong feeling in favour of the introduction of the electric light into the colleges, museums, etc., was very generally expressed, and the prospects of the Company appear to be satisfactory. It was stated that the works were making rapid progress, and that the supply of electricity would be commenced early in the spring.

COMPANIES' REPORTS.

ELECTRIC CONSTRUCTION CORPORATION.

Directors: Sir Henry C. Mance (chairman); Sir Daniel Cooper, Bart., G.C.M.G.; Messrs. John Irving Courtenay, George Dibley, Joseph Ebbsmith, Henry P. Holt, J. Spencer Balfour, M.P. (vice-chairman); Joseph Moseley, James Pender, John B. Verity, H. Granville Wright. Manager and chief engineer, Thomas Parker, M.I.C.E. and M.I.E.E.

Report of the Directors to be submitted to the shareholders at the ordinary general meeting, to be held at Cannon-street Hotel on Tuesday, 22nd inst., at 3 p.m.

In submitting the accounts of the Corporation up to 30th September last, the Directors point out that the period embraced by the previous profit and loss account extended over nearly 16 months, whereas the present report only includes the working at Wolverhampton for one year, and at the Millwall works for eight months. The Directors are happy to state that the business of the year has been of a satisfactory and promising character, and it will be seen from the accompanying accounts that it has resulted in a profit balance of £46,166. 16s. 8d., from which the Directors have carried £10,000 to reserve for depreciation, leaving a net balance of profit and loss for the year of £36,166. 16s. 8d., which, with the £3,877. 11s. 1d. carried forward from last year, makes a total of £40,044. 7s. 9d. available for disposal. The development of the electro-chemical patents of the Corporation is advancing to the satisfaction of the Directors, and a substantial addition to future profits may be expected from this source. As the shareholders are already aware, Mr. Ebbsmith has resigned his appointment as managing director of this Corporation in order to take charge of the British Electro-Chemical Agency, Limited, to which these patents have been transferred, but in order that the Corporation might not be deprived of the benefit of his experience he has been elected to fill the vacancy on the Board caused by the lamented death of Sir Robert Fowler. The Directors have leased the Millwall works on favourable terms to the Electrical Power Storage Company, Limited, with an exclusive license to that company to use the storage battery patents belonging to the Corporation. This arrangement has already proved of great advantage to both parties, and it has the further merit of enabling the manager and chief engineer, Mr. Parker, to concentrate his energies on the important contracts and work which the Wolverhampton works have in hand. In continuance of their previous policy, as approved by the shareholders at the last general meeting, the Directors have written off capital expenditure the sum of £20,000 out of the sale of patents sold or transferred to other companies during the past year. The sale of these patents will not in any way prejudice the working of the Corporation; on the contrary, it is confidently expected that their development will bring a considerable amount of work to the factory at Wolverhampton. The Directors have pleasure in recommending a dividend of 6 per cent., payable on 22nd January next, leaving a balance of £10,721. 19s. 4d. to be carried forward to the present year's account. The prospects of business are very satisfactory. The Corporation is at present carrying out, in addition to ordinary work, large and important contracts for the Liverpool Overhead Railway, the electric lighting of the city of Oxford, and also for the electric plant for the Crystal Palace district. The balance of the authorised debenture issue is now required for the working of the Corporation, and the Directors will be glad to receive applications, as soon as possible, on the enclosed form, in order to avoid the expense of a public issue. In accordance with the articles of association, four of the Directors—viz., Sir Henry Mance, with Messrs. Ebbsmith, Holt, and Moseley—retire from the Board, all of whom are eligible and offer themselves for re-election. Messrs. Broade, Paterson, and Co., the present auditors of the Corporation, retire and offer themselves for re-election. In conclusion, the Directors desire to express their continued and increased confidence in the future of the undertaking.

PROFIT AND LOSS ACCOUNT FROM 1ST OCTOBER, 1891, TO 30TH SEPTEMBER, 1891.

Dr.	£	s.	d.	£	s.	d.
Expenses and cost of production during the year ended 30th September, 1891, at Wolverhampton and Millwall, including engineering department and laboratory expenses				129,890	16	10
Depreciation of machinery, furniture, etc.				3,099	18	8
Head office expenses, including rents, patent expenses, Directors' fees, Managing Director's salary, accountancy, etc.				11,423	7	1
Auditors' fee				105	0	0
Interest upon debentures and temporary loans				3,949	12	10
Other expenses, including the cost of advertising, issuing debentures, law charges, etc.				13,968	16	0
Balance carried to reserve for depreciation	£10,000	0	0			
Carried to balance-sheet	36,166	16	8			
				46,166	16	8
				£208,604	8	1

Cr.	£	s.	d.	£	s.	d.
Sales and work executed during the year ended 30th September, 1891				160,036	5	9
Cash and shares for licenses granted, patents sold, and profits upon formation of subsidiary companies	£64,710	0	0			
Less estimated amount applicable to capital account	20,000	0	0			
				44,710	0	0
Transfer fees, rents received, and miscellaneous receipts				3,858	2	4
				£208,604	8	1

BALANCE-SHEET, 30TH SEPTEMBER, 1891.

Dr.	£	s.	d.	£	s.	d.
Capital—						
49,000 ordinary shares of £10 each	499,000	0	0			
100 founders' shares of £10	1,000	0	0			
	500,000	0	0			
Less calls in arrear	8,158	19	5			
				491,841	0	7
690 first mortgage debentures of £100 each				69,000	0	0
Liabilities—						
Trade accounts, law charges, etc.	16,849	5	10			
Loans	32,945	6	5			
Interest accrued on debentures	1,925	16	7			
Directors	1,419	9	9			
				53,139	18	7
Contingent liabilities—						
On pending contracts and in shares partly paid up and bills receivable discounted ... £90,000						
Reserve for depreciation, etc.	15,000	0	0			
Added this year	10,000	0	0			
				25,000	9	0
Profit and loss account:						
Balance as per statement to September 30, 1890	48,290	15	8			
Deduct: Reserve. £15,000 0 0 ,, Dividend 29,413 4 7	44,413	4	7			
	3,877	11	1			
Balance of profit and loss for the year as above	36,166	16	8			
				40,044	7	9
				£679,025	6	11

Cr.	£	s.	d.	£	s.	d.
Purchase of the works, businesses, and patents of Elwell-Parker, Limited, of Wolverhampton, and of the Electrical Power Storage Company, Limited, of London, patent rights, etc., according to last balance-sheet	£312,816	16	5			
Less depreciation of machinery, etc ... £3,099 18 8 And transfer from profit and loss account 20,000 0 0	23,099	18	8			
Expenditure since—				289,716	17	9
Land and buildings at Bushbury, new works, Wolverhampton				13,621	19	5
Plant and machinery, etc.				10,684	8	10
Furniture, fixtures, etc.				824	2	4
				£314,847	8	4
Shares in subsidiary companies at par, shares included in the original purchase at nominal value, and debts due by subsidiary companies				241,123	7	6
Book debts—Wolverhampton, Millwall, and head offices				64,001	11	0
Stocks at Wolverhampton and Millwall				31,966	13	10
Cash at bankers				13,994	11	8
Bills in hand				13,091	14	7
				£679,025	6	11

The Auditors' certificate states that they consider the balance-sheet correctly shows the financial position of the Corporation as on the 30th September, 1891. Although the shares, etc., stand at £241,123. 7s. 6d., the £120,000 written off capital expenditure, in effect is a reserve against this item. They think £10,000 a proper sum to add to reserve account for depreciation, etc.

FOWLER-WARING CABLES COMPANY.

Directors: Messrs. Wm. Fowler (chairman), Walter Chamberlain, R. W. Eddison, George Fleming, the Hon. J. S. Gathorne-Hardy, M.P., Colonel J. T. North, R. S. Waring.

Report to be presented to the shareholders at the third ordinary general meeting, to be held at Winchester House, Old Broad-street, E.C., on Friday, the 18th inst.

In submitting their second annual report the Directors express their regret that they are unable to allow a profit on the work of the year. At the same time, they are glad to say that the business of the Company has made great progress. There has been a marked increase in the volume of business done as compared with last year, and the gross profit has been sufficient to cover all ordinary and some extraordinary expenses. The factory is well equipped and organised, and the work done there is unsurpassed. Since the close of the financial year numerous orders have been received, to say nothing of many important enquiries. The Directors, therefore, fully retain their previously expressed confidence in the future of the business, further details of which will be found in the annexed report of the general manager. There is, however, no manufacturing business in which the competition is keener than it is in ours, and a new undertaking must necessarily require time for development and to make its manufactures known. Meanwhile, as materials must be paid for almost on delivery, and as it is often necessary to give considerable credit to our customers, as well as to provide for special additions to plant to enable us to meet the new demands constantly being made by electrical engineers, the Directors believe that the employment of a larger working capital than the Company possesses would be justified by results, and would materially assist in bringing the concern to a dividend-paying position. The Directors have again not drawn their fees, but on this occasion they have debited the amount in suspense, as they anticipate a state of things when the payment of this amount will be fully justified by the condition of the business. The retiring directors, Mr. Walter Chamberlain and Mr. R. W. Eddison, being eligible, offer themselves for re-election. The auditors, Messrs. Cooper Bros. and Co., offer themselves for re-election.

GENERAL MANAGER'S REPORT.

During the past year the Company has made notable progress in each department of its work, and our manufactures have been successfully applied and their efficiency proved in every important branch of electrical engineering. In electric lighting, among the larger orders we have delivered to the London Electric Supply Corporation 10 miles of large concentric conductors for the distribution of their high-tension currents through the streets of London. These cables are now laid and are working daily under conditions which demand the most perfect efficiency; the best testimony to their success is the fact that the corporation have ordered an additional 10 miles to be delivered during the next few months. In shiplighting, eight of the new warships at present building for the Admiralty have been wired by cables of our manufacture, and some of the large shipbuilders have adopted them for installation on board the steamships building in their yards. In the electric lighting and transmission of power in mines, the cables have been extensively used, and they contribute very greatly to the success of this difficult and important work. We have also manufactured special wire for use with the explosives employed in blasting and torpedo experiments, and for many more of the ever-increasing number of electrical applications. In telegraphy the leading railway companies are adopting lead-covered wires for the tunnels, yards, and stations, and many miles of our cables have been so used during the past year. In telephony the Government has employed our cables exclusively for the London end of the Paris telephone lines, and also for connecting up the various centres in London. Large orders have also been entrusted to us by the private telephone companies, and we are at present laying a 100-wire cable through Paris for the French Government telephone service. We have recently dispatched 15 miles of similar cable to Sydney for the Government telephone service there. Only our cables will be employed for the new central station at Sydenham, which will supply electric light to the Crystal Palace during the forthcoming exhibition. Other large orders are in hand, and the prospect of future business is exceedingly good. In my last report I referred to the fact that rubber-covered wires were often specified to the exclusion of all others, and that we deemed it advisable to be prepared to supply these if it became necessary. In many instances we have been able to secure the adoption of our cables in preference to those which are rubber covered, and all the work referred to in this report has been carried out with cables manufactured under those patents and processes which are the exclusive property of the Company. The works at North Woolwich have never yet been worked to anything approaching their possible output, and consequently we cannot yet show a profit on our work. Sufficient, however, has been done during this year to demonstrate not only the value of our manufactures and the extent and variety of their application, but to justify the firmest confidence in the future of the Company.

(Signed) ALFRED E. MAVOR.

Dr. BALANCE-SHEET, SEPTEMBER 30, 1891.				£	s.	d.
Capital—						
Authorised, 40,000 shares of £5 each	£200,000	0	0			
Issued, 20,000 shares £4. 10s. per share paid up	90,000	0	0			
300 founders' shares issued as fully paid to vendors	1,500	0	0			
	91,500	0	0			
Deduct arrears of calls	150	0	0			
				91,350	0	0
Creditors				15,286	12	9
Liability on bills receivable discounted	1,657	6	2			
				£106,636	12	9

Cr.				£	s.	d.
Cash at bankers and in hand				1,165	15	2
Debtors				13,656	0	10
Stock				14,011	4	2
Office furniture in City offices and factory				515	7	3
Shares in other companies				25	0	0
Machinery and plant as per last account 30th September, 1890	£8,977	12	2			
Additions during the year	6,116	14	8			
				15,094	6	10
Works and buildings—						
At North Woolwich, as per last account September 30, 1890	12,907	17	1			
Additions during the year	1,662	5	9			
				14,570	2	10
Patents and goodwill as per last account September 30, 1890				41,000	0	0
Preliminary expenses as per last account September 30, 1890				3,325	8	6
Profit and loss account as per last account September 30, 1890	1,764	16	2			
Add loss for the year ending September 30, 1891, as per account	1,508	11	0			
				3,273	7	2
				£106,636	12	9

PROFIT AND LOSS ACCOUNT FOR THE YEAR ENDING 30TH SEPTEMBER, 1891.

Dr.	£	s.	d.
Directors' fees (not drawn)	2,000	0	0
Rent, rates, and taxes	1,815	2	9
Office expenses and advertising	888	16	10
Fees on patents	186	0	0
	£4,889	19	7

Cr.	£	s.	d.
Gross profit on cables, after deducting salaries and other expenses	3,377	13	7
Transfer fees	3	15	0
Balance—loss for the year ending 30th September, 1891, carried to balance-sheet	1,508	11	0
	£4,889	19	7

NEW COMPANIES REGISTERED.

California Gas, Water, and Electric Light Syndicate, Limited. Registered by Oldfield, Bartram, and Oldfield, St. Stephen's-chambers, Telegraph-street, E.C., with a capital of £2,000 in £1 shares. The objects for which this Company is established are sufficiently indicated by the title.

Automatic Gas Lamp Lighter Company, Limited.—Registered by Church, Rendell, Todd, and Co., 9, Bedford-row, W.C., with a capital of £6,000 in £1 shares. Object: to carry into effect an agreement, made November 26, between P. Everitt of the first part, G. Salter and Co. of the second part, and this Company of the third part, and generally to carry on business as mechanical, gas, and electrical engineers, machinists, brass and iron founders, etc. There shall be four Directors. The first are P. Everitt, G. Poore, G. Salter, and J. H. Birch. Qualification, 250 shares. Remuneration to be determined in general meeting.

Chloride Electrical Storage Syndicate, Limited.—Registered by Hays, Schmettau, and Co., 31, Abchurch-lane, E.C., with a capital of £262,500, in 250,000 £1 preference shares and 12,5000 £1 founders' shares. The objects for which the Company is established are to adopt and carry into effect a provisional agreement, made November 30th, between the Electric Storage Battery Company and the United Gas Improvement Company of the one part and J. A. E Hickson, on behalf of this Company, of the other part, for the acquisition of certain patents and to develop and work the same, and to carry on the business of an electrical company in all its branches; and, further, to carry on the business of engineers, ironfounders, copper smelters, steel makers, engineers, merchants, bankers, colliery proprietors, company promoters, brokers, etc. The first subscribers are:

	Shares.
J. E. Yates, 9, Solent-crescent, West Hampstead	1
W. J. Tomey, 24, Granard-road, Wandsworth Common	1
G. S. P. Cooke, 53, Chadwick-road, Peckham	1
H. J. Rumball, 16, Ruvigny-gardens, Putney	1
F. B. Liley, 58, Sandmere-road, Clapham	1
G. S. Ludlow, 34, Werter-road, Putney	1
E. J. Newbatt, 57, Cowley-road, North Brixton	1

There shall not be less than three nor more than nine Directors; the first being the first seven signatories to the memorandum of association. Qualification, 500 shares. Remuneration, £1,500, divisible.

CITY NOTES.

The Sims-Edison Torpedo.—Major-General E. Harding Steward has joined the Board of the European Sims-Edison Electrical Torpedo Company.

City and South London Railway.—The receipts for the week ending December 13 were £815, as against £810 for the week ending December 6.

Eastern Extension Telegraph Company.—An interim dividend for the quarter ended September 30 last of 2s. 6d. per share has been declared by the Directors, payable on the 15th prox.

An Electrical Finance Company is being formed, with a capital of £100,000, to assist local authorities in dealing with the powers granted to them under the Electric Lighting Acts.—*Financial News.*

St. James's Electric Light Company.—The 10,000 new £5 preference shares recently offered to shareholders by the Directors at 30s. premium have been largely over-subscribed. These shares were allotted on December 11.

Interim Dividend.—The Directors of Crompton and Co., Limited, have declared an interim dividend at the rate of 7 per cent. per annum on the preference shares, and 5 per cent. per annum on the ordinary shares for the half-year ended September 30 last.

The Phosphor Bronze Company inform us that they have acquired the sole license for the manufacture of Bull's metals, which they now supply in the form of ingots, billets, castings, forgings, stampings, rolled rods and sheets. The extreme malleability, tensile strength, and durability of these alloys render them specially adapted for the wants of engineers, shipbuilders, and others requiring a strong non-corrosive metal of high quality at a moderate price. The inventor and patentee, Mr. John C. Bull, has joined the Company as consulting engineer and chemist, and will superintend the manufacture of his alloys at their various works.

Elmores.—A "Confiding Investor" writes to the *Financial News* in a most lugubrious strain about the prospects of this Company. He points out that the accounts to June, the end of the financial year, have not yet reached him. He also says that he "invested in the Company's shares on the strength of a letter from Mr. W. Elmore, in which he said: 'I now predict that at no very distant period the shares will stand at £50 instead of their present price' (then about £8). The shares are not now saleable at £3. Circulars issued by the persons connected with the promotion of the Company estimated the profits to be earned as sufficient to pay a dividend of 100 per cent., and carry over £34,000 surplus as well each year. The Company has been in existence nearly three years, and although a dividend of 50 per cent. was paid to the original shareholders, this was derived from the sale of one of the patents to a subsidiary company, and has, therefore, nothing to do with the trading profits. As the subsidiary company has so far shown no results, the dividend already mentioned is therefore no test whatever of the value of either patent."

London County Council.—We take the following list of tenders received for electric lighting at the central offices of the London County Council from the *Contract Journal* of Wednesday last:

J. D. F. Andrews and Co.	£1,490	0	0
Barclay and Sons	1,500	0	0
Fowler, Lancaster, and Co.	1,564	0	0
J. Jackson	1,570	0	0
H. F. Joel	1,586	0	0
J. R. Powditch and Co	1,598	0	0
H. South	1,604	0	0
Croggon Company, Limited	1,655	0	0
Drake and Gorham	1,731	0	0
F. G. Howard	1,745	0	0
Woodhouse and Rawson	1,810	0	0
Edmundson's, Limited	1,815	0	0
London and Lancashire Electric Company	1,825	0	0
General Electric Power Company	1,830	0	0
Paterson and Cooper	1,842	0	0
Reid Bros.	1,964	0	0
Electrical Supplies and Fittings Company	1,996	0	0
Mather and Platt	2,000	0	0
Planet Electrical Engineering Company	2,056	8	2
Brush Electrical Engineering Company	2,136	0	0
Crompton and Co.	2,140	0	0
Latimer Clark, Muirhead, and Co.	2,192	7	0
W. Goolden and Co.	2,229	0	0
Ewart and Son	2,230	0	0
Johnson and Phillips	2,288	0	0
Sharp and Kent	2,300	0	0
Girdlestone and Co.	2,300	0	0
Spagnoletti and Co.	2,590	0	0
Lund Bros. and Co.	2,600	0	0
Siemens Bros. and Co.	2,715	0	0
Laurence, Scott, and Co.	2,815	0	0
Suter and Co.	2,996	0	0

The number of tenders (32) is probably one of the largest sent in for any public competition, and exemplifies in the most striking way the great differences in estimating the cost even of straightforward office lighting—the last tender being exactly double the first. The accepted tender is not yet announced.

PROVISIONAL PATENTS, 1891.

DECEMBER 7.

21344. **Improvements in dynamo-electric machine commutator brushes.** James Ernest Spagnoletti, Goldhawk Works, Shepherd's Bush, London.

21354. **Improvements in apparatus for measuring electric currents.** Hermann Aron, 6, Lord-street, Liverpool.

21363. **An improved electric lift.** Isaa Peral, 433, Strand, London.

21369. **Improvements in switches for primary or secondary batteries.** Henry Harris Lake, 45, Southampton-buildings, London. (Hermann Müller, Germany.)

21379. **Improvements in dynamo electric machines.** Alexander Bernstein, 4, South-street, Finsbury, London.

DECEMBER 8.

21442. **Improvements in secondary or storage batteries.** Henry Harris Lake, 45, Southampton-buildings, London. (Isaiah Lewis Roberts, United States.) (Complete specification.)

21448. **Improvements in the manufacture of filaments for incandescent lamps.** Sydney Pitt, 24, Southampton-buildings, London. (Ludwig Karl Bohm, United States.) (Complete specification.)

21449. **Improvements in switches for electrical purposes.** Frank Geere Howard, 18, Berners-street, London. (Complete specification.)

21476. **Improvements in electric meters.** Addison Goodyear Waterhouse, 323, High Holborn, London. (Complete specification.)

DECEMBER 9.

21505. **Improvements in methods for producing multiphase alternating currents and in apparatus therefor.** Rankin Kennedy, Carntyne Electric Works, Shettleston, Glasgow.

21506. **For improvements in and connected with waterwheels for producing motive power for electric lighting purposes and hydraulic works on streams or tides.** William Gordon Potter, 8, Middle-pavement, Nottingham.

21533. **A new or improved method for registering or recording telegrams and the like.** Duncan McCallum, 36, Thurlestone-road, West Norwood.

21541. **An improved method of mechanically strengthening dynamo-electric machine inductors.** Lazarus Pyke and Edward Stephen Harris, 433, Strand, London. (Complete specification.)

21551. **Improvements in apparatus for the projection of electric light.** Sydney Pitt, 24, Southampton-buildings, London. (Sautter, Harlé and Co., France.) (Complete specification.)

21565. **An improved microphone.** George Frederick Redfern, 4, South-street, Finsbury, London. (Wilhelm Deckort, Austria.) (Complete specification.)

DECEMBER 10.

21571. **Improvements in an apparatus for showing the principle of the utilisation of heat as a source of electricity.** James Stevenson, 20, High Holborn, London. (Victor Hirbec, France.) (Complete specification.)

21651. **A new or improved method of making and breaking electric circuits, and of apparatus therefor.** William Henry Dingle and John Mackenzie Urquhart, Norfolk House, Norfolk-street, London.

DECEMBER 11.

21668. **Improvements in electric switches.** Alexander Marr, 70, Market-street, Manchester.

21683. **Improvements in electrical visual signalling apparatus.** Cornelius Edward Kelway, 122, St. Donatt's-road, New Cross, London.

21690. **An improved safety switch.** Ernest Bohm and Ernest Bailey, 21, Finsbury-pavement, London.

21691. **A variable resistance switch.** Ernest Bohm and Ernest Bailey, 21, Finsbury-pavement, London.

21702. **Improvements in and relating to the construction of electrodes of large dimensions for accumulators, and to supporting the same in their cells.** William Phillips Thompson, 6, Lord-street, Liverpool. (Armand Vanden Kerckhove, Belgium.)

21720. **Improvements in switches for regulating currents of electricity.** John Charles Howell and Percy Edward Pownall, 55, Chancery-lane, London.

21723. **Improved means and appliances connected with electrically regulating the feed of carbons to arc lamp.** William Routledge, 166, Fleet-street, London.

21728. **Improvements in electric arc lamps.** Addison Goodyear Waterhouse, 45, Southampton-buildings, London. (Complete specification.)

DECEMBER 12.

21766. **Improvements in apparatus for measuring the expenditure of electrical energy.** Sigmund Schuckert and Alexander Wacker, Temple-chambers, London.

21778. **Electrical safety signalling apparatus for railway trains, also applicable for applying the brakes.** August Peters, jun., 28, Southampton-buildings, London.

21783. **A novel combination of metallic wires to dispense with the use of electromagnet or solenoid as such in arc lamps.** Frederick John Beaumont, 166, Fleet street, London.

SPECIFICATIONS PUBLISHED.

1887.

11802. **Incandescent lamps.** Shippey. (Second edition.) 8d.

1890.

18523. **Electrically heating, etc., solid bodies.** Zerener. 1s. 1d.

18556. **Electrical switches.** Pierce. 6d.

1891.

49. **Galvanic batteries.** Wensky. 6d.

584. **Dynamo-electric motors.** Hutin and Leblanc. 8d.

1004. **Indicator for electric potentials.** Thomson. 6d.

1035 **Primary batteries.** Maquay. 8d.

1138. **Guard for electric light globes.** Munns. (Mino and another.) 6d.

2522. **Electric light pendants, etc.** Lane and Cottrell. 8d.

3198. **Galvanic batteries.** Poudroux. 8d.

12828. **Electric motors.** Lake. (Thomson-Houston International Electric Company). 1s. 3d.

16090. **Dynamo-electric machines.** Conly. 8d.

17652. **Electric arc lamps.** Lake. (Thomson-Houston International Electric Company). 8d.

17971. **Electric clock winders.** J. W. and C. F. DuLaney. 6d.

17994. **Electric batteries.** Scheithauer. 6d.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Brush Co.	—	3⅜
— Pref.	—	2¼
India Rubber, Gutta Percha & Telegraph Co.	10	19½
House-to-House	5	5
Metropolitan Electric Supply	—	10¼
London Electric Supply	5	1⅜
Swan United	3¾	4½
St. James'	—	9
National Telephone	5	4⅜
Electric Construction	10	7
Westminster Electric	—	6¾
Liverpool Electric Supply	5 3	6¼ 2¼

NOTES.

Yarmouth.—A new tramway is to be started at Yarmouth.

Sofia.—The last date for the reception of tenders for the canalisation of Sofia is left over till Feb. 13.

Constantinople is to have 500 new gas lamps erected. Assaf Bey should be pressed to place electric lights on the Golden Horn.

Elmore Copper Company.—We have received copies of the accounts of the Elmore Copper-Depositing Company, too late, however, for publication in this week's issue.

Odessa.—The Continental Edison Company, of Paris, have obtained from the Municipality of Odessa a contract for lighting several streets and public buildings by electricity.

Lecture.—Mr. T. Carey, of the Thomson-Houston Electric Company, has been invited by the Royal Engineers, Woolwich, to read a paper on electric traction in January.

Appointment.—The City of London Electric Lighting Company have appointed Mr. David Cook, late superintendent and consulting electrical engineer to the Corporation of Glasgow, as their general manager.

Dover.—A letter was read at the last meeting of the Dover Finance Committee from the solicitors of the Brush Electric Lighting Company, stating that they would submit a draft copy of the agreement shortly.

Catalogue.—We have received "List B" from Messrs. Woodhouse and Rawson containing a very large and handsome selection of electric light brackets, electroliers, glass shades, and ship, house, and office fittings.

Fareham.—A special meeting of the Local Board of Health was held last week to consider the matter of the Fareham Electric Lighting Company's provisional order. The consent of the Board was given to the company's application.

Venice in London.—One of the great sights of Christmas time is to be the magnificent spectacle which is being rapidly brought into shape at Olympia, "Venice in London," with real buildings, canals, and gondoliers. We hope to be able to give some description of it when opened.

Richmond.—The Board of Trade were just upon the point of revoking the Richmond electric lighting order, when the town clerk informed them that the contract with Messrs. Latimer Clark, Muirhead, and Co. was ready to be signed, and the threatened revocation of the order was withheld.

Appointment.—We have to make a correction as to the appointment of electrical engineer to the Huddersfield Town Council. It is not Mr. W. C. Mountain, but his brother, Mr. A. B. Mountain, at present assistant manager to the Newcastle Electric Supply Company, who has received the appointment.

Tenders for Durban (Natal).—Mr. W. H. Radford, C.E., of Nottingham, has been instructed by the Corporation of Durban to invite tenders for the supply of electricity to the inhabitants of Durban and for the lighting of the public streets. The population is about 24,000, and there are no gas works.

Cardiff.—Mr. Sidney Walker suggests that two streets in Cardiff should be experimentally lighted by temporary plants, one by arcs and the other Sunbeam lamps, and the cost of each fully tested. Mr. Walker says he believes the arc lamp will gradually disappear from public lighting in favour of high-power incandescent lamps.

Mechanics' Almanack.—The nineteenth year of publication of "Calvert's Mechanics' Almanack and Workshop Companion" (John Heywood, etc., price 4d.), sees this little book appearing in its customary interesting and useful form, full of information items, recipes, diagrams, and articles of interest to mechanics and working engineers.

Lancaster Tramways.—In the annual report of the Lancaster Tramways Company, the directors regret that they are not yet in a position to report any progress as to the question of the company adopting electricity as a motive power, or in extending the tramway to Scotforth. An extension of time has been granted by the Board of Trade.

The National Telephone Company have not less than 19,000 miles of trunk mains. It is estimated that the company put through not less than 70 million calls per annum throughout their whole system. After January 1st, 1892, all the call offices in Glasgow will be open to the public at a charge of one penny for three minutes' conversation.

Finchley.—Messrs. Latimer Clark, Muirhead, and Co., having offered to bear the expense of the provisional order and carry out the works required for supply of electric light, the letter was referred over for future consideration of the Finchley Local Board. A letter was also received from Mr. John Wright, United Electric Light Company, 64, Victoria-street.

Fleetwood.—At the monthly meeting of the Fleetwood Commissioners the chairman mentioned they had got three of the best firms in the trade to make their reports, and it was really a case of competition. The clerk said he was awaiting the third report. Immediately he received this report the Electric Lighting Committee would be called together.

Prize.—The Italian technical journal, *Elettricita* (Via Meravigli, Milan) offers a price of 2,000f. for a new practical simple primary battery for industrial use. The competition will remain open from January 1 to August 31, 1892, open to all senders. The jury will be composed of responsible and competent persons. Details can be obtained at the above address.

City Lighting.—The supply of current to private consumers by the City of London Electric Company was commenced last week from the company's central station at Meredith's Wharf. The company is now prepared to connect consumers on both sides of the eastern end of Queen Victoria-street, and expects to be able to connect those of the west end of Queen Victoria-street early in 1892.

Paris Electric Railway.—We learn with pleasure, says *Electricité*, that the scheme for providing a tubular electric railway for Paris is progressing satisfactorily. The commission appointed to report from the technical point of view upon the proposed plans, have unanimously adopted them. One of the numerous stages necessary for the inauguration of the line from the Bois de Boulogne to Vincennes has thus been successfully passed.

Telegraph in India.—The erection and maintenance of telegraph lines in some districts of India are amongst the most troublesome engineering problems of the day. It is proposed to run a line over the high mountain ranges of Kashmir to Gilgit. Frost reigns supreme for many months in the year, and often a solid snow curtain is formed along the line between post and post, while occasionally the whole line, posts and all, is buried beneath the snow.

Electricity at the World's Fair.—Messrs. Siemens and Halske, under certain conditions as to patents, rates, and storage, have formally applied for a space of 17,250 square feet under cover, and 2,150 square feet out of doors.

at the Chicago Exhibition. The exhibit will require 1,500 h.p. to 2,000 h.p. for the operation of the machinery. An electric railway will be laid, electric boats supplied, and a model theatre, besides public lighting. A special building is asked for.

Progress of Invention.—The U.S. Patent Office will exhibit at the Chicago Exhibition a comprehensive array of models to illustrate the wonderful progress of mechanical civilisation. One group of models will show the progress of the printers' art from Gutenberg's crude invention to the latest rotary perfecting and folding printing press, capable of turning out newspapers at the rate of many thousands per hour. Other groups will show the development of the steam engine, sewing machine, agricultural machinery, the application of electricity, and other branches.

Kensington.—The Works and Sanitary Committee of the Kensington Vestry, at their last meeting stated that they had considered the letters from the Board of Trade forwarding the description of the system of electric lighting proposed to be substituted by the Chelsea Electricity Supply Company in place of that now in force, and recommended that the Board of Trade be informed that the Vestry saw no objection to the proposed new system being adopted, provided a code of rules and regulations similar to those now in force be imposed by the Board.

The Hughes Telegraph.—There are now 100 Hughes printing telegraphs at work in Berlin, out of a probable total of 2,000 in the countries using this wonderful instrument. The great advantages of speed and clearness are well shown in the fact that the usual speed of the Hughes telegraph is 1,200 to 1,300 words an hour in printed Roman letters, and in the Berlin chief telegraph office are operators capable of sending 1,600 words in the hour. In a great number of lines running from Berlin there are more than 500 messages sent a day, the activity of the Morse system being limited to 200 a day.

Fast Electric Railroads.—It is not all honey in the working of an electric road, especially when 25 miles an hour are run with what are practically ordinary tramcars, run at this speed in competition with the railway company. On the St. Paul and Minneapolis track, to which we have before referred, a car jumped the track, and four persons were fatally injured. With such conditions true railway conditions come into play, and the 18ft. car with a short wheel base were certainly not satisfactory, and double-truck cars are to be used in future. The unfortunate incident will at least serve to indicate the kind of service for which electric cars are now being employed.

Waterford.—At the last meeting of the Waterford Corporation, a letter was received from Mr. T. F. Strange, law adviser to the Corporation, stating that he had taken the necessary steps to obtain the provisional order to enable the Town Council to light the city by electricity. He applied for £150 to carry the matter out. This amount was voted. The Special Lighting Committee have decided to apply to Government for a loan of £20,000 to carry out the public lighting, and though in all probability the cost will not amount to this sum, the amount now paid for public lighting will more than cover the instalments of principal and interest levied by the Government.

Featherstone.—At a meeting of the Featherstone Local Board last week a letter was read from Lord Masham's agent, offering to light up North Featherstone for a term of 15 to 20 years with electric light, or so long as the coal on the Ackton estate lasted and continued to be worked, for the sum of £20 per year and 4d. per hour during the time the current was used. The Board favoured Lord Masham's offer, but it was stated that Castleford Gas Company had the right of lighting North Featherstone, and it was also mentioned that a license would be required from the Board of Trade before the Board could adopt the offer made by Lord Masham. The offer was accepted.

Exhibition at Earl's Court.—A United Services Exhibition is to be held in the grounds at Earl's Court, to be opened in May next. It is considered that the auxiliary forces—and particularly the volunteers—have not been properly represented in any exhibition. The Welcome Club, in the Western Gardens, will be reconstituted especially for the benefit of officers and their friends. The buildings and grounds will be illuminated by electric lighting and otherwise, on a grander scale than heretofore, and first-class music will be made a special feature. Naval and military displays, drills, sports, and competitions will be provided, and prizes will be offered for various competitions.

Budapest Electric Railway.—Some particulars recently given of the proposals for the electric railway between Vienna and Budapest reveal a daring and comprehensive plan. The distance is 150 English miles, which is to be covered in 75 minutes, the speed in regular working to be 200 kilometres, or 124 miles an hour. There would be two main generating stations, with 100 sub-stations along the route, and only four stopping-places. The cars are to be 130ft. long on four bogie carriages, and shaped to cigar-shaped point to reduce the air resistance. The cars are to be provided with two powerful motors at each end, the current being picked up from bare conductor rails by special wheels. It is thought permission will be obtained, and the line put in hand before very long.

Typological Museums.—Lieut.-General Pitt-Rivers, D.C.L., F.R.S., read a very suggestive paper before the Society of Arts last week, upon "Typological Museums," as exemplified by the Pitt-Rivers Museum at Oxford and his provincial museum at Farnham, Dorset. He advocates evolutionary arrangement in a large rotunda, and incidentally mentions that his museum, although in the country, was visited by 7,000 persons a year. At the conclusion of his paper General Pitt-Rivers exhibited a number of diagrams illustrative of the evolution of the modern rifle and bullet through all its stages, some of which had dropped out of public knowledge; and in connection with this he suggested the desirability of a similar series being arranged, before it was too late, of various electrical appliances, many links in which might be easily forgotten.

The Kimberley Exhibition.—The executive of the Kimberley Exhibition having invited Lord Knutsford to become patron of the exhibition, have received a communication from him intimating his readiness to act in that capacity. Messrs. Rodwell and Co., Port Elizabeth, and Devine, Gates, and Co., Capetown, are appointed forwarding agents for the exhibition. The plans of the buildings are now being decided upon by the committee. The prospectus of the exhibition has, we learn, been received by Mr. Atkinson, the London manager. It states that all European exhibits will be conveyed from the coast to Kimberley and taken back to Port Elizabeth or Capetown free of charge. Medals and certificates will be specially awarded for the most economical mining, electric lighting, and agricultural machinery. Special prominence is to be given to all classes of machinery adapted for use in the colony.

Private Bills.—Monday being the last day for the deposit of private Bills at the Private Bill Office of the House of Commons, there was a large attendance of parliamentary agents who have charge of schemes for the coming session. Plans, sections, and books of reference were deposited on November 30th, but notice has also been given of several Bills in respect of which no plans are required to be deposited. Among the Bills are the following: Baker-street and Waterloo Railway, Central London Railway, City and South London Railway (Islington Extension), Great Northern and City Railway, Hampstead, St. Pancras and Charing Cross Railway, County Council (General Powers), Subways and Tramways, London Tramways (extensions), National Telephone Company, New Telephone Company, Limited, North Metropolitan Tramways, Ward Electrical Car Company, Limited, and Waterloo and City Railway.

Thunderstorms.—Mr. W. Marriott, before the Royal Meteorological Society last week, gave a paper on "Thunderstorms," in which some interesting statistics were given. In 1888 there were 113 days, and 1889, 123 days on which thunderstorms occurred; damage was done on 33 days in 1888, and 38 in 1889. Thunderstorms appear to travel at an average rate of 18 miles per hour, but sometimes at a higher rate in squally weather. The author thinks that individual thunderstorms do not travel at a greater rate than 20 miles an hour, and that they take the path of least resistance, favouring flat, low ground. He believes that the thunderstorm formations are small atmospheric whirls, in all respects like ordinary cyclones; and that the whirl may vary from one mile to 10 miles or more in diameter. There are frequently several whirls near together, or following one another along the same track. The numerous oscillations in the barometric curve are evidently due to the passage of a succession of atmospheric whirls; and it appears that lightning strokes are most frequent when these oscillations are numerous.

Electric Fittings.—One of the most remarkable signs of the times in the electrical world has been the immense strides taken by the comparatively new firm of Rashleigh, Phipps, and Dawson, of Berners-street, W. This firm, no doubt enjoying the patronage accruing from their connection with Mr. Phipps, the eminent architect, have pushed with energy all the advantages they have received, and are now well-known electrical contractors to numbers of West-end and country houses. The firm have a fine showroom in Berners-street, where a brilliant display of 1,200 lamps, all wired for light in an immense variety of artistic fittings, can be seen. The current is obtained partly from their own batteries and partly from the Metropolitan Supply Company. They have recently taken new premises in Stanhope-street, Euston-road, which is fitted up as a first-class art metal-working factory. They have specially engaged seven artists—designers and modellers—several of them exhibitors and prizemen. The number of workmen employed by the firm is very nearly 200, and will rise to 300 in the beginning of the year when the new works are opened. We are promised some novel and pleasing effects in the exhibits by the firm at the Crystal Palace Exhibition, mostly in the adaptation of artistic special fittings and reflected light arrangements. The importance of this exhibit can be best gauged by the fact that last week they had no less than 90 workmen at work fitting it up at the Crystal Palace.

Weston-super-Mare.—At the last meeting of the Weston-super-Mare Town Commissioners, the report of the Finance Committee meeting was read, at which the clerk produced the taxed costs of Messrs. W. Smith and Sons and Mr. J. C. Ball incidental to the Weston-super-Mare electric provisional order, amounting together to £370. 13s. 11d. The committee recommended that the clerk be instructed to apply to the Local Government Board for sanction to a loan of £375 for payment thereof and incidental expenses. At a meeting of the Electric Lighting Committee on the 18th November, Mr. Preece's report, dated the 20th September, 1890, was read, and the clerk was instructed to enquire what other towns had done in the matter, and to ask (1) whether they have undertaken their own work, and, if so, the number and description of lamps; (2) whether they maintain a supply for public and private purposes; (3) the capital outlay; (4) if let to a company, whether they could lend the committee a copy of their agreement, or acquaint them with the terms of such letting; (5) whether they have any suggestion to make for the guidance of the committee. At a meeting of the committee on the 26th ult., the committee, after some discussion, recommended that they be authorised by the Board to visit, on its behalf, such towns where electric light has been adopted for public and private purposes, and to obtain all information on the subject which they may be able to produce. The clerk was further asked to enquire of Dover and Fleetwood whether they had done anything definite towards carrying out their powers of electric lighting since August last.

Gauzantes Miners' Lamp.—After experiments lasting over six years a French electrician, M. G. N. Gauzantes, now residing at Cardiff, has produced a primary battery miners' lamp that is regarded with much interest in the neighbourhood. The composition of the solution, as usual, is a secret. The battery consists of a tin case containing two cells, round the sides of which are placed, four in each cell, vertical slips of carbon; in each cell a zinc rod is suspended from the cover into the generating fluid. Binding screws are fitted to the carbon and zinc poles, and the lid is tightly fastened. Upon this lid is placed the small incandescent lamp, with its guard and reflector. In size, the lamp is about 4in. wide, 2in. broad, and nearly 8in. in height, and easily carried by means of a light handle affixed to the side. The weight of the lamp when fully charged is about 3lb. 12oz., and it gives a surface light equal to ¾ c.p., or ¼ candle in excess of that given by the most powerful safety lamp. The prime cost of construction is only 5s., and the weekly working cost of replenishing the battery is estimated at 5½d., while the life of the lamp is reckoned to be five years. The metal which serves as the anode is refined by a new and simple process, and allows a maximum generation of current without fear of rapid polarisation. The exciting fluid is stated to be a new combination, giving in a single liquid all the properties necessary for the production of a regular and constant current, and reabsorption of the sulphates produced. The lamp has been tested in Belgium and at the Gelli mines with satisfactory results. One of the lamps was burnt for 10 hours in the *Western Mail* office. The invention is being taken up by M. Soldenhoff and a syndicate.

Factory Lighting at Dundee.—Maxwelltown Factory, Dundee, was one of the first works in Dundee fitted up with a complete electric light installation. There are 700 lamps of 16 c.p. each and two arc lamps of 5,000 c.p. each employed in the lighting. The main dynamo is a compound-wound Manchester, by Messrs. Mather and Platt. It is constructed to give an electrical output of 420 amperes 100 volts, equal to 700 lamps of 16 c.p. each. It is driven by a double-cylinder diagonal engine with cylinders 12in. diameter with a 16in. stroke, and the motor runs at 120 revolutions per minute. The engine was also made by Messrs. Mather and Platt. The power is transmitted by means of an 11in. link belt passing under a jockey pulley, which serves to tighten the belt when running. A few lights ranging from 10 c.p. to 130 c.p. are required in different departments of the works all day, and to provide for these there is a small Electric

Construction Corporation dynamo of 80 amperes 100 volts placed in the dynamo-room, and driven from the main shaft of the factory engine. This dynamo runs all day, and lights can be switched on to it from any part of the works. There is also a night circuit of 50 lamps of 16 c.p. each. This is composed of a small Tangye engine driving an Electric Construction Corporation dynamo of 30 amperes 100 volts, with wires and one or two lamps in the different departments, so that the watchman going his rounds at night can switch on a light in any flat. The office, lodge, engine-room, and boilers, however, are lit from this circuit, and the dynamo runs all night. Messrs. Lowden, of Dundee, who have carried out the installation, have a large number of contracts on hand both in Scotland and England, towards which the very satisfactory character of the Dundee installations has greatly conduced.

Bradford.—At the meeting of the Bradford Town Council last week, the minutes of the Gas and Electricity Supply Committee included a recommendation to the Council to direct that all necessary steps be taken for extending the area for lighting by electricity so as to include the district of Allerton. Alderman Priestman (chairman of the Gas and Electricity Supply Committee), in moving the adoption of the minutes, said that the recommendation as to supplying Allerton with the electric light came before the Council in consequence of an important memorial from that district. The memorial was signed by all the influential people in Allerton, and asked that the committee would establish an electric lighting plant there. If the Council would agree to the abstract resolution contained in the minutes, he would pledge himself that not a farthing should be spent without the matter again coming before the Council. Before spending any money whatever he would come to the Council with all the necessary particulars prepared, showing the exact expenditure it was proposed to incur and the income which would probably be derived from the undertaking. In the meantime something perhaps might be heard from the Clayton Gas Company. Alderman Edhouse seconded the motion. It was suggested that the supply might be also extended to Heaton, to Thornbury and Tyersal, and to Frizinghall and part of Bolton. Alderman Priestman said that if the other outtownships which had been mentioned would send in memorials like that from Allerton, and if the Allerton undertaking proved successful their petition would probably receive the same recognition. The memorial from Allerton was no one-sided document, but pledged those who had signed it to take the light at a given price. The minutes were agreed to.

Typewriter and Telegraph.—It is probably not generally known to what an extent the use of the typewriter has superseded the pen, or stylus, in telegraph-receiving in America. Mr. S. J. Pryor, in an interesting article in *Electricity*, puts the recent revolution in very clear form. The typewriter, backed by the Phillips code, has revolutionised telegraphy, and the capacity of the press service is nearly doubled. The night report of the United Press averaged eight thousand words on each of its six wires, and eighteen thousand for the whole day. Now, the night report runs to fourteen thousand, and the whole day's service to thirty thousand words. Instead of thirty to thirty-five words a minute, twenty to thirty copies each of "flimsy," the typewriter can maintain a speed of seventy words for thirty copies. Second-rate senders have become first-rate men, and the danger of paralysis, or "losing the grip," is done away with entirely. The consequence is that the senders, previously too quick for the receiving operators, have now to hurry up, and Mr. Walter P. Phillips, general manager of the United Press, has devised and carried out a system of contractions and logograms, such as "nbh" for "neighbourhood," "f" for "of the," and so forth. With the aid of the Phillips' code the sending operator can transmit 60 words a minute with greater ease than he could send 30 without it, and at this rate the receiving operator, with his typewriter, can keep up pleasantly. The actual speed of transmission has risen from between 30 and 35 words to between 50 and 60 words a minute. On a recent occasion 3,500 words, on a news special, were sent to all papers in the service in 55 minutes. The only objection seems to be the extra noise, and this is counteracted by making the sounder more powerful. The Remington and Caligraph seem to be most used. The typewriter is employed at the landing of the submarine cables of the Commercial Company with the same success. This is true also of nearly every telegraph service in the land. "The click of the type-writer accompanies the click of the sounder in every corner of the land," says Mr. Pryor, "and it is only a matter of a very short time when its use in telegraphy will be universal."

Tinpot Electricity.—We are favoured from time to time, at intervals of a few weeks or months, of an enthusiastic inventor of a peculiar turn of mind who continually sounds the praises of a wonderful discovery he has made which is to revolutionise the process of producing electricity. This inventor, whose brows are deeply furrowed with the burden of his idea, has "discovered" how to produce electricity without motion and without chemical action, by hydraulic pressure upon a simple meat-tin. General Booth is not "in it" with our caller, for, according to his account, all that is required is to connect the water supply from the mains to the tinpot and without using the water, the pressure produces, so he affirms, a small but decided current, almost enough to light a 5-c.p. lamp! We remember very well indeed some years ago being introduced by a friend, a gentleman in good trade in the City, to his office or warehouse lad, who he averred had made a momentous discovery, so simple and yet so far extending that before disclosing it he had prepared a paper to be signed that no use should be made of it. Electric energy to any extent was to be produced at nominal cost. We saw this lad, whose face was enlivened by his vast idea, and his energy for warehouse work quite upset by the burden of thought. After hearing his declamation on immense possibilities, we asked him first whether he had ever heard of the law of "conservation of energy"—magic touchstone of engineering problems. As we thought, he had not. He was disappointed, but perhaps almost relieved to hear of this law—"*ex nihilo nihil fit.*" And then (without signing papers) he divulged the secret that he had so long hugged to his bosom. It was this. The current from a cell will energise a magnet, but this current is *not lost*. It could be sent through a second magnet, and a third, and a fourth, and so on, until the whole might be strong enough to move St. Paul's. Had he thought, we enquired, that possibly one cell would only cause the current to flow around one magnet and maintain its strength, and that for two magnets of this strength two cells would be required just as much as if they were not one after the other in series, but entirely separate. He had not, and only realised them with apparently hardly-repressed tears that his wonderful electricity was but "tinpot electricity" after all. We have often wondered what became of that boy, who for a brief period enjoyed all to himself the possession of a power beside which that of Aladdin's lamp or Dumas' Count of Monte Cristo's diamonds paled into insignificance.

CURRENT "FROM THE MAIN."

BY W. S. HEDLEY, M.D.

With the electric light circuit at our doors, the question of utilising it as a source of supply for electro-therapeutic work is literally brought home to us. I propose at present merely to point to some methods by which this can be done with comparative ease and safety. The advisability of so using it is another and larger question, which it is not intended to enter into now.

We have, first of all, to face the fact that the light current is generally supplied to houses at not less than 100 volts, and that the quantity used for even a single incandescent lamp is much in excess of that ordinarily required for medical purposes. It is manifest, therefore, that some modifying arrangement must be adopted before the current from the ordinary light circuit can be used with safety. Let us take an instance—a house containing incandescent lamps requiring 50 watts to properly light them. The E.M.F. of the supply is 100 volts, so the current must be half an ampere or 500 milliamperes. Many lamps now take only 30 watts, making the current 300 milliamperes. We may therefore assume that the safety-fuse of such a lamp (and every lamp ought to be so protected) would act if more than 500 milliamperes passed, and automatically break the circuit, so that no harm could be done to the lamp. Here, then, we have the maximum current obtainable from a single lamp lead of an ordinary light circuit—viz., 500 milliamperes. This maximum for medical and surgical purposes of course leaves an excessive margin, and could doubtless be reduced if desired by using a safety-fuse adjusted to break the circuit with a smaller current; but considering the power that must be available for, say, the di-polar bath, and the current strengths that have been talked of in connection with the electrolysis of fibroids, there does not appear to be any real reason for fixing our limit of safety at less than 500 milliamperes.

The next question is how best to modify this maximum so that we may use little or much of it at will. For this purpose, if the current supplied be the continuous one, an adjustable rheostat is all we require, provided we keep a milliampere-meter, or at least some current measurer, in circuit. Such rheostat ought to possess quite 50,000 ohms resistance, working down by steps not exceeding 1,000 at a time to zero. The objection to such an arrangement is that in the event of the E.M.F. in the mains rising suddenly from some disturbing cause, the safety-fuse may act and (automatically cutting off the current) give a more or less violent shock to any patient under treatment at the time. Further, that if, as sometimes happens, the fuse is somewhat sluggish in its action, a current considerably in excess of that intended may pass through the patient for the instant previous to the automatic breaking of the circuit. In a well-regulated current supply, such as that now provided by our English electric light companies, the risk of accidents of this nature is very small. Still, it is well to bear in mind that in using a current from an electric light main we must be prepared against an unexpected and undesirable increase of power, instead of the unexpected, undesirable, and vexatious decrease of power which frequently accompanies battery currents.

Since commencing this article I have been informed that an instrument has been devised, and will shortly appear, which provides for the utilisation of continuous-current installations for galvanisation, faradisation, electrolysis, etc., and which affords perfect protection in the use of such currents, being so arranged that it is impossible for more than the maximum current to which the instrument is set to pass to the patient. The maker supplies me with the following particulars: The instrument contains two switches for turning on the continuous or the faradaic current. Either of the two has to pass through a 16 or 32 candle lamp to prevent (in case of short circuit) the destruction of galvanometer, coil, etc. The current strength is graduated by means of four graphite and one metal rheostat. The latter contains altogether 1,000 ohms on 28 subdivisions; the former contains 1,000, 10,000, 50,000, and 100,000 ohms respectively, which can be varied without any shocks. All the other connections—current reverser, De Watteville's key, etc.—are exactly as in the combined batteries by the same maker.

In dealing with alternating currents from dynamo circuits, the necessary modification for therapeutic uses can be easily made by means of a "transformer." The function of a transformer is, of course, to "tranform"—*i.e.*, to alter the relative values of E.M.F. and current strength as supplied by the mains, and the special use of the medical transformer is not only to render high-potential currents safe by "transforming down," but also (by means of the Du Bois Reymond sedge arrangement) to secure the necessary regulation of current strength. One advantage of such transformers is that the current obtained from the secondary circuit, which is that used for therapeutic purposes, does not come direct from the main, and therefore the risk of "shock" to the patient is reduced. It is, however, as necessary that a safety-fuse, or some automatic cut-out, form part of the circuit with alternating as it is with continuous current. A special transformer for alternating current (by the same maker as the continuous-current arrangement already referred to) was recently described in the *Lancet*. It acts as a reversed induction coil—*i.e.*, a weak intermittent current of high E.M.F.—passes through the primary coil which is wound with many turns of fine wire, and induces strong currents of low E.M.F. in the secondary coil wound with a few turns of thick wire. The instrument seems to work very satisfactorily, and I can personally testify to the regular, even, and pleasant character of the current obtained by its use when attached to a lamp lead upon the Grosvenor Gallery circuit in London.

In this connection it may not be out of place to remark that the quality of a current produced by galvanic induction in the secondary coil is not quite of the same quality as that obtained from an alternating dynamo, the former being of a sharper and more accentuated order, in addition to which, in the best of coils, irregularity of vibration is a very frequent occurrence. The dynamo current is comparatively smooth and wavy, the alternations being "demarcated" by a neutral point smoothly and rapidly passed, rather than by an interval. A "curve of sines" represents it.

The outcome of our enquiry, therefore, seems to be this: that whilst it is clear that electric light circuits cannot be used for medical purposes without the strictest measures of precaution against the influx of strong currents, there is also good reason to suppose that efficient protection can be secured by the adoption of the above-indicated or other suitable methods.

ELECTRICITY AT THE CHICAGO EXHIBITION.

In the paper by Mr. James Dredge before the Society of Arts on "The Columbian Exposition of 1893," the proposed arrangements were gone into at considerable length. We give the following extracts dealing with the machinery and electricity buildings.

THE MACHINERY HALL.

The machinery hall is 500ft. wide and 850ft. long; with its annexes it is to cover an area of about 17 acres. At one end and connected with it is an annexe 500ft. wide and 550ft. long. The position of this very important building is shown on the plan, where it will be seen that its principal façade faces on the Grand Avenue; it is this façade upon which the chief architectural detail is concentrated. Beyond it and at the head of the short canal branching from the basin, the façade of the machinery hall is connected with a colonnade that adds greatly to the imposing effect, and at the same time serves as a screen to separate the stock yards of the exhibition from the rest of the grounds. This colonnade, which is of considerable extent, is carried as far as the agricultural hall, so that the visitors can pass from one to the other without being exposed to the weather. The general scheme of the main building of the machinery hall behind the ornamental exterior is rectangular, and the vast space is divided into three galleries, each about 130ft. span; there will, therefore, be no very extensive engineering work in this building. In the centre of the hall the three galleries just referred to will be crossed by a transept of about the same width, and the intersections are marked by the construction of three domes. At each corner is a large pavilion with a domed roof; entrances to the building will be provided in each of these pavilions, but the main portals will be on the north and east sides, where the classic porticoes will be placed; these porticoes will be flanked by towers 200ft. in height. Between the corner pavilions and the central entrances on the north and east sides, the exterior will consist of open loggias, or colonnades, two storeys in height and with internal galleries; these are covered by a flat roof. A similar flat roof covers the outer part of the building on the south and west sides, but as these sides will not be so much exposed, elaborate architectural effect is dispensed with. The building will be lighted by skylights over the flat roofs, and by raised lanterns at the top of the main arched galleries; the greater portion of the domes will also be glazed. Most of the framing of this building will be of steel, though all the skeleton of the exterior is of timber very cleverly arranged and covered with cement and "staff," in the same way as all the decorative effects of a similar nature are obtained throughout the exhibition. The foundations, however, are of wood, designed on the same lines as those already referred to when I was speaking about the great buildings of the city. Only as the structures at Jackson Park are temporary, it was not considered necessary to incur the considerable cost of iron and concrete platforms, but precisely the same method of distributing the weights has been adopted except in those cases where the uncertain nature of the ground rendered piling a necessity. Extensive galleries will be erected around the interior of the building at the same height above the ground as the galleries of the loggias before mentioned. They will be reached by eight main staircases and a number of subsidiary ones, as well as by elevators. The annexe to the machinery hall will be built largely of wood, and will have no pretension to architectural elaboration. On the south side of the main building a boiler-house will be erected, 80ft. wide and 600ft. long. In this building will be generated all the steam required for the great power station that is to furnish the exhibition and grounds with the necessary energy, calculated at present at 25,000 h.p. The engines by which this force is to be generated will be placed together within the machinery hall, a sufficient area on the south side being reserved for that purpose. It is intended that both engines and boilers, with all the auxiliary machinery, should constitute exhibits, and as this is a point upon which some of our manufacturers will certainly feel considerable interest, I reproduce here the official information as to the terms on which steam engine exhibits, intended to form a part of this power station will be received. "Engines aggregating 25,000 i.h.p. will be required. These must all be compound, either cross or tandem, horizontal or vertical, or triple-expansion. These engines may be of any automatic type, high or low speed, and must be condensing, manufacturers to furnish condensers. Steam pressures will be of 125lb., 150lb., and 200lb. per square inch; either pressure may be used at the option of the exhibitor. The work to be done will be generating electricity either for arc or incandescent lighting, power transmission, or driving line shafting. No engine shall be of a smaller capacity than 150 h.p., nor of a greater than 1,000 h.p. If it is desired to drive line shafting, engines should be of low speed and capable of working up to 325 h.p., with an economical working load of 160 h.p. For operating dynamos they may be of any type, and capable of developing from 150 h.p. to 1,000 h.p. The basis on which engines will be accepted will be as as follows: Such engines are to be consigned by the manufacturers to the World's Columbian Exposition, and will be placed upon foundations free of all cost to the executive, which will prepare foundations of concrete, according to drawings furnished by the manufacturer, will make all steam and water connections, maintain, operate, and furnish all supplies, such as oil and waste, during the exposition, the manufacturer to remove the engine at the end.

"The engines will remain the property of the exhibitor, and will be considered as exhibits in operation. Exhibitors will be required to furnish operating engineers, whose wages will be paid by the executive, and who will be subject to the direction at all times of the Chief of Construction. Such manufacturers as decide to exhibit engines under the above conditions should make application without loss of time to their respective commissions."

This very large power station will be utilised not only for transmission of machinery in motion in the machinery hall, but for distributing current throughout the various buildings and grounds, for power, lighting, and other purposes. It should be mentioned in this place that it is the present intention of the executive to introduce a complete novelty for driving machinery in motion. The great success that has attended the distribution of energy by compressed air on the Popp system in Paris, has encouraged the executive to employ this means of operating the machinery in motion. The advantages attending this innovation will be very great; not only can cold-air machines and refrigerating machinery be supplied direct, but the machinery hall will be kept cool—a very important consideration during the summer. Besides this, all the many annoyances to exhibitors and visitors arising from leaking steam-pipes and defective joints will be avoided; leakage will be an advantage instead of an inconvenience (except as regards loss of power), and a great complication in the mains beneath the flooring will be avoided.

If this project is put into execution, a large amount of air-compressing machinery will be required; this will be treated by the executive much in the same manner as the engines already referred to above.

Returning to the power station, it will be realised that the greater part of the 25,000 h.p. will be required to drive electric current generators, which will also be exhibits. A very elaborate system of underground mains will be laid in tunnels constructed so as to reach all the buildings requiring light or power, and every part of the grounds. A circular electric elevated railway will be constructed so as to include the principal buildings, and as on this very frequent trains will be run, a large amount of power will be consumed. Current will be delivered to all the separate buildings of States and foreign countries, and such power (of course with some exceptions) as will be required to show machinery in motion in various parts of the grounds will be furnished from the central station. It is the intention of the executive, during the exhibition, to subject—if the exhibitors approve—all the machinery employed in connection with the central station to an elaborate and careful system of trials, so that the actual and relative efficiencies may be ascertained.

The electrical department, the chief of which is Mr. F. Sargent, desires to give every possible encouragement to foreign electrical engineers and contractors, to induce them to compete for the contracts of laying mains, providing lamps, generators, motors, and other plant that may be required in carrying out the electrical system of the exhibition, and also to tender for the maintenance of such work during the continuance of the exhibition. Such competition would no doubt be of great interest to some of our own industries, but I am informed that if such work were done as an ordinary contract, and not as an exhibit, the tariff regulations would make it difficult, if not impossible, for any foreign contractor to compete. If, therefore, the exposition authorities desire such foreign co-operation seriously, it rests with them to meet these difficulties so as to place foreign manufacturers on equal terms with those of the United States.

The space reserved for Great Britain and her colonies in the machinery hall is 40,000 square feet, about the same space which she occupied at the Centennial Exposition of 1876. Whether under the existing conditions of trade and competition with the United States it will be possible for us to occupy this large area, it is too early to predict; it must be borne in mind that any machinery shown in the transportation, electricity, or mines buildings will be placed there at the expense of machinery hall. Still, I think that there are sufficient manufacturing engineers in this country whose interests in the United States—either actual or prospective—or with other countries, are important enough to induce them to make a fair, though perhaps not a representative display. The architectural work of the machinery hall is by Messrs. Peabody and Stearns, of Boston.

THE ELECTRICITY BUILDING.

The electricity building covers an area of 250,000 square feet, and is estimated to cost 130,000dols. The architects are Messrs. Van Blunt and Howe, of Kansas City, and the design appears not only admirably adapted for its purpose, but sufficiently well-proportioned and ornamental to take a front rank among the many splendid buildings on Jackson Park. The main entrance to the building faces on the great central avenue, near the administration building. The principal architectural feature at this end of the building is a portico and colonnade extending for the whole width on each side of the monumental entrance, over which are inscribed a series of names famous in the annals of electrical science. The main tower at this end reaches an elevation of about 200ft., those at the sides being somewhat shorter and of more slender proportion. Except for the two large bays at the back of the building, the plan is rectangular, the length being 690ft., and the width 345ft. The centre of the building is occupied by a large hall, running from end to end, and about 115ft. span, flanked by a double row of columns and aisles 70ft. in width. Important entrances will occupy the centre of the building on each side, and access is gained to the galleries by broad stairways occupying the middle of the building. The end bays will be glazed so as to afford as much light as possible. Large as are the dimensions of this building, it may be confidently expected that they will be insufficient to accommodate the exhibit. Electricity and its practical application will be one of the largest and most important sections of the exhibition, and during the next two years there will, doubtless, be many new developments not yet brought into a practical form. In connection with this building, some general particulars of the scheme of electric lighting at Jackson Park may be given. The plans have been elaborated by the chief electrical engineer, Mr. Sargent, and his proposals have been accepted by the committees on electricity, on the grounds and buildings; and by Mr. Burnham, the chief of construction. As upon every other point, so in this matter of illumination the executive appear determined to surpass all that has been hitherto attempted in this direction at international exhibitions. In 1889 only three of the main buildings were opened at night to the public and furnished with electric light. It has now been decided that complete arrangements shall be made for lighting every one of the great halls at Jackson Park, as well as the extensive grounds. The scheme elaborated up to date refers to nine of the great buildings, and comprises 5,180 arc lamps of 2,000 c.p. each, and 24,700 incandescent lamps of 16 candles. Except in the fine arts, the administration, and the women's buildings arc lights will be employed, and will be distributed as follows: In the machinery hall there will will be 600; in the agricultural hall, 600; in the electric building, 400; in the mines and mining building, 400; in the transportation building, 450; in the horticultural hall, 400; in the forestry building, 150; and in the industrial arts building, 2,000. As just stated, there will be no arc lights employed in the fine arts buildings, but in their place the interior will be lighted by 12,000 incandescent lamps. The administration building will be illuminated in the same manner, and about 10,000 16-candle lamps will be required for this purpose. The lighting of the women's building will be mixed, and comprise 180 arc lamps and 2,700 incandescent lamps. In addition to the lighting supplied by the authorities, any exhibitor who requires it will be able to obtain current for lighting his display, in any manner he thinks fit, conformably with the lighting regulations. It is presumed that this current will be furnished to private consumers at a fixed and very moderate tariff. The arrangements for lighting the grounds, for the illuminated fountains, for private lighting, and miscellaneous purposes, have not yet been completed. It is decided in principle, however, that every one of the numerous pavilions and official buildings will be abundantly supplied with electricity, so that any reasonable amount of light can be obtained, and gas will be practically, if not actually, unknown at Jackson Park as an illuminant. It is intended, amongst other novel applications of the electric light, to illuminate the harbour enclosed within the pier and breakwater, already referred to, either wholly or in part, with submerged incandescent lamps so arranged that the light may be thrown upwards towards the surface of the water. Such an arrangement would undoubtedly consume a large amount of power, but the effect would be very striking and attractive.

It should be mentioned that already a large amount of electric power is available on the grounds, an extensive installation having been completed and put in operation. It has been ordered by the executive that the contractors are not to be allowed to use steam power, but that they must work all their machinery by electricity. This has been done to reduce the risk of fire during the progress of the work. All the sawmills set up for the industrial building are driven by this means, and the contractors for the administration and horticultural buildings are already using a considerable amount of the same power. There are at the present time at least a dozen motors driven by current furnished from the temporary central station. This is an entirely novel application of electricity in connection with exhibition buildings.

A very considerable amount of current will also be required for lighting the grounds through the long winter nights, during which work will be carried on continuously by different shifts of men. The arrangements made between the executive and the directors of the labour unions, limit the length of daily work to eight hours. By this means the executive is confident that they will carry the work forward to its conclusion, without any interruption due to labour troubles.

THE MINING BUILDING.

Besides these, in the mining building will be shown the mechanical appliances of mining pans, cradles, and rockers, modern and complicated amalgamating, concentrating, and smelting machinery; crushers, centrifugal quartz mills, stamps, rolls, jigs, frue vanners, concentrators, roasting and melting furnaces, reverberatory and matte furnaces, bullion cars and pots, crucibles and ladles—in short, the entire plant of milling, smelting, and refining works of different descriptions. It is intended to demonstrate the process of extracting precious metals in the most thorough manner. Gold and silver bearing rock will be passed through the various stages until the pure metal is exposed. The mining machinery manufacturer will be given ample opportunity to display the excellencies and demonstrate the usefulness and economy of his machines.

In the mining machinery section will be shown every species of apparatus, simple and complex, employed in working a mine from the lowest level to the dump. Methods of timbering, ventilating, and lighting the various slopes, levels, and galleries will be shown by examples. Trams, hoists, and automatic dumps, engines for pumping, rock breakers, screens, grizzlies, and other sizing appliances will be shown. Improved diamond drills, and contrivances for loading and unloading coal and ores, and for their storage; automatic stevedores for transference on the surface; patent self-emptying cars; wire ropeways with their outfits of buckets, etc., coal tips, steam shovels, belt conveyors, etc., will complete the methods by which the mining operations of the present age are conducted.

For the purpose of practical study, the historical division of mining and metallurgy will be provided. The literature, maps, models, etc., of the leading educational institutions of the United States will present to the student in this department, at the Columbian Exposition, an opportunity of reviewing the entire subject of historical and statistical mining. Mining engineering will be adequately represented by surveys and plottings, by projections of underground work and models, and by literature descriptive of the methods of running shafts, tunnels, construction of mine workings, and the handling of ores.

Concert.—An evening concert was given by the Central Institution Musical Society at the Central Institution on Friday last. The programme included a fine selection of high-class songs, violin, flute, and piano solos.

THE

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All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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USING UP ACCUMULATORS.

Whatever electrical engineers may say, or whatever they may wish, it will remain a fact in electric tramway questions that the objections, real and unreal, to overhead conductors, and the difficulties with underground or closed conduits, leave a large field open in tramway work, which, if it is to be satisfactorily conquered by electric traction at all, must be conquered by accumulator traction. This will be so for two reasons—first, that the well-known difficulties of introducing direct current into crowded English towns militates in favour of self-contained cars; and secondly, the equally well-known fact that the tramway companies in general have no capital to spare for alterations favours the gradual introduction of electric traction which can best be brought about by self-contained storage cars working among the ordinary horse cars. Against all this there is the great and primary question of the cost of running, which so far has seemed to weigh very much in favour of the direct-current systems. In actual efficiency, if the figures were practically tested, we doubt whether there is much to be said greatly in favour of either, for recent tests on American lines seemed to show that overhead direct-current lines only usefully employed 50 per cent. of the brake engine power generated, while accumulator cars cannot be much below this efficiency. With these rival systems, therefore, the question resolves itself into a three-cornered fight of convenience, first cost of plant, and current cost of running. Of these the last is the determining factor, and this in accumulator work resolves itself into one of depreciation of batteries.

It is open to very decided question whether electrical engineers have not been working upon the wrong tack in attempting to lengthen the life, perfect the working machinery, so to speak, of the accumulator, and whether it would not pay better to attend less to the beauty of manufacture of storage plates and more to their strength and cheapness, even if less long lived. In a word, to put the matter in plain light, should we use accumulators as watches or as fuel? Should we polish, and manœuvre, and scheme that we may get the most perfect action, the most long-acting chemical machine; should we treat the storage cell, in fact, as if it were a delicate machine to be treated with the utmost care and delicacy, or had we better rather consider the lead plates as so many tons of fuel to be purchased as cheaply as possible and used to their utmost for the six, eight, or twelve months and then cast aside for new ones?—consider the lead, in fine, as a part of the fuel and not as a part of the plant. To do this would need a very different attitude both of accumulator manufacturers and of the users of the cells. But this might be done, we think, by the introduction of a plate requiring the minimum of formation and manufacture, of which, in fact, the ordinary lead of commerce is the principal cost. We alluded last week to a new cell invented by Mr. Reckenzaun, which promises well in the direction we have ventured to suggest. This plate is made direct out of plain lead strip, previously oxidised on the surface by the ingenious method of passing it through an electric arc; the strips are roughly tacked together, forming a plate capable of being knocked about without fear of breaking, or over-discharged without fear of buckling. The plate is therefore a simple Planté cell, manufactured and formed with the smallest cost for labour. We have seen plates which have been worked for eighteen months and are still in good condition. Mr. Reckenzaun has been zealously working upon this question for some years, and we certainly think he has made a distinct advance towards the proper treatment of storage cells as a rough, electrical engineering and not a delicate, electrican's question. Without saying that the grand problem of a cheap and efficient accumulator is definitely solved, it seems as if a light were shining from the point we desire to see it, and we hope it is true, as we hear, that the manufacture of these lead strip accumulators will be taken up in a commercial spirit—and that they will prove successful. Accumulator traction will receive the impetus for which we have all been so long waiting, when, as we have said, the plates can be used up as fuel rather than tended as delicate machinery.

CURRENT "FROM THE MAIN."

This is the title of an article in the *Lancet* of December 19th, by W. S. Hedley, M.D. We reprint it elsewhere, inasmuch as the object of every electric light supply company is to pay a dividend, and in order to do this it must sell current whenever and wherever possible. The idea so many electrical engineers take, that in the first place undivided attention must be given to the distribution of current for light, is so much lost opportunity. It is not only light, it is use in every direction that is wanted. Once get the terminals inside a house, and then prove to the inmates that it is not light only, but—well, whatever else is wanted in the house. Electrical apparatus is the most suitable of all, and for almost everything. Let us take one example. Hitherto bars and bolts have been the grand means of keeping our houses safe from depredation. Burglar alarms have been fixed, but in our opinion all such alarms have erred on the side of complexity. A burglar must walk, and two or three "tread" alarms would be far more effectual than apparatus at each door and each window. The alarms could be made part and parcel of the bell system of the house, could by the turn of a handle be put into or out of circuit—that is, could at a fixed time at night come into play, and be cut out in the morning. No doubt an inmate of the house might avoid the various "treads," but with such a restricted area for police work detection would be comparatively easy. It might be found advisable to have the safety devices separate from the bell system, and to put the apparatus in a circuit direct from the house terminals. There would be no difficulty in such an arrangement. It requires, however, some energetic men from America, or some patentees of a foreign nationality, to come over here and promote a company to float apparatus of this character upon a market that is ready to be exploited. A patented article—patent valid or invalid matters not—is the only article that will go down with business men. Few will be found to say: "Make my house or office safe," but will buy any nostrum that is presented to them in the form of a patent. However, this suggestion is only introduced for the purpose of hinting at a huge undeveloped field of business which someone will have to explore. Dr. Hedley refers to another field—the use of current for surgical and medical purposes. The simple question for the doctor is, Can the current be kept under control? In the majority of cases where current is used the answer may be unmistakably in the affirmative. In other cases the variations of resistance are excessive, and here lies the difficulty. It may be remembered that some years ago electric cautery was pronounced in some quarters to be the grandest discovery of the age for surgical operations. But we hear little or nothing of electric cautery now. You may easily render and keep a platinum wire white hot, but on bringing that wire into contact with moist flesh the resistance of the circuit is altered, and the wire with the same cells may not even reach a red heat—a heat altogether too low for the purpose for which it is wanted. Assuming, however, that in most cases where the electric current is required, and a continuous current is available, will a better method be found than by taking the current required from a secondary battery? Whatever we may come to later, we do not yet charge such batteries from alternate-current mains, so that when these are installed other apparatus is necessary. While, then, it may be profitable to instal hundreds of lamps, a few shillings may be picked up by supplying the wants of doctors and of dentists. Anything that helps to bulk out that load curve ought to be welcome.

SAVORY v. LONDON ELECTRIC.

The judgment of Mr. Justice Kekewich in this case will be read with considerable interest. It is almost needless to say we cannot quite agree with it. One sentence in the judgment is exceedingly strong. It reads: "That there is now no imminent danger against which the plaintiffs are entitled to protection is clear beyond dispute." If this means anything, it means that the defendants have taken every precaution to obviate the danger; and the adverse judgment cannot be taken as against the work of the defendants as it now stands, but is based upon the position of affairs at the time the action was commenced, and the lack of knowledge we have of the unknown. The latter cannot well be remedied, nor can industrial developments be expected to wait till scientific men are in a position to make a "positive statement respecting possible results under hypothetical circumstances." The position of new enterprises is bad enough in any case. Vested interests seem to be touched on every hand, the general outcry being that of mother to child—"don't" and "musn't." Mr. Justice Kekewich took a certain view as regards the plaintiffs' action, but time has shown they might have waited the completion of the permanent work, or at any rate, that portion in which the previous disaster commenced, and then they would have seen the precautions taken against the recurrence of such accidents. The remainder of the building, we take it, will not be subjected to similar dangers. A good deal of the importance depends upon the terms of the undertaking the plaintiffs are willing to take, and we trust the full text of this document will be made public, as it will serve as a guide to what may and what may not be done by supply companies.

ACCUMULATORS AT THE FRANKFORT ELECTRICAL EXHIBITION.

BY CARL HERING.

Curves giving the difference of potential of an accumulator at various stages of discharge and charge have been given very frequently, and are well known to those specially interested in the subject; but curves showing the change of capacity at different rates of discharge are not so well known, and for this reason those in Fig. 1 may be of interest. In this figure the vertical distances for the upper curves represent ampere-hours, and for the lower ones amperes, while the horizontal distances in both cases represent hours. The curve *a b* shows the actual capacity as obtained from measurements of a pair of plates after they had been in use some time. The curve *c d* represents that which is guaranteed by the company. The curve *e f* shows the currents corresponding to the curve *a b*, while *g h* represents those corresponding to *c d*.

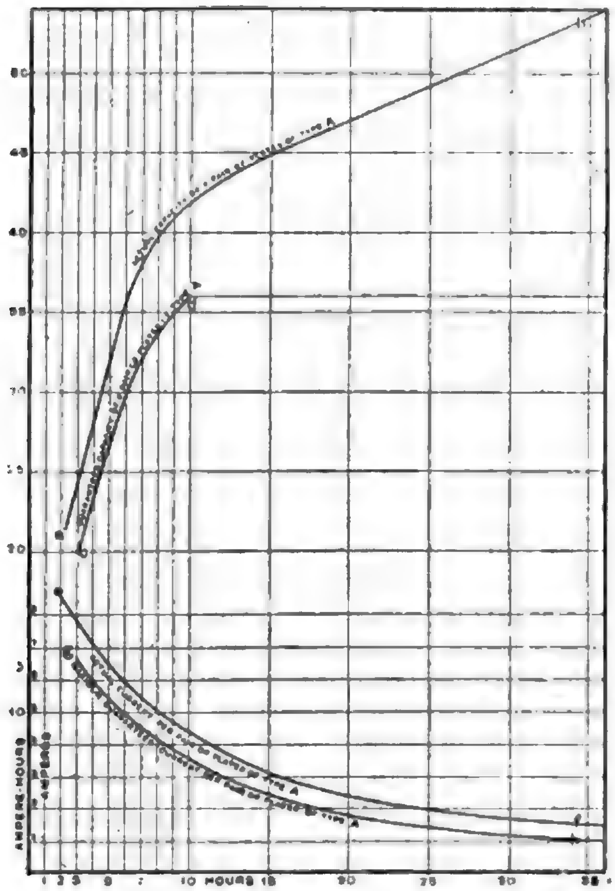

Fig. 1.

It will be seen that the curve *a b* increases very rapidly, especially at first, showing how very much the capacity varies with the rate of discharge; if the capacity were independent of the rate of discharge this curve would of course be a horizontal line, and, therefore, the nearer this curve comes to a horizontal line the better will be the accumulator for rapid discharges. It will be seen from this curve that at a 10-hour rate the current is 4·2 amperes and the capacity is 42 ampere-hours. At double the rate of discharge—that is to say, a discharge in half the time—the curve shows the current to have been 6·5 amperes and the capacity 32·5 ampere hours, which is 23 per cent. (or about a quarter) less than the other. At a three-hour rate, which is exceptionally rapid for accumulators, the current is only about eight amperes, which is only about double that at a 10-hour discharge; the capacity is 24 ampere-hours, or 43 per cent. less than that of a 10-hour discharge. It will be seen from the latter that in a discharge of one-third of the usual 10-hour rate the capacity is reduced to nearly half, while the current is only about twice as great. These curves, of course, will be different for different makes of accumulators. The thinner the layer of active material, the more nearly horizontal the curve will become. The curves shown here are those exhibited by the Cologne Accumulator Works—these accumulators are known as the "Hagen."

Table I.

—	A.	B.	C.	D.	E.	F.	G.	H.
De Khotinsky	100	—	—	—	—	3·5	7·3	—
"	100	—		—	—	8·0	6·8	—
Hagen	100	1·7	1·1	·57	·36	3·0	10·6	—
"	107	2·3	1·4	·44	·28	5·0	8·4	—
"	108	2·9	1·9	·29	·19	0·0	6·8	—
Accumulator Company (American)*	110	3·7	2·2	1·0	·60	3·7	11·0	—
Tudor	111	1·6*	1·3	·32†	·25	5·0	9·8	—
Oerlikon (Schoop)	115	2·9	2·3	·50	·40	5·3	—	Glass
Julien (American)	120	6·7	5·2	·72	·57	9·2	6.9	Glass
Hagen	128	2·7	1·7	·39	·24	7·0	7·9	Glass
De Khotinsky	500	—	—	—	—	8·0	5·1	—
"	500	—	—	—	—	3·5	5·3	—
Oerlikon (Schoop)	500	2·8	2·4	·52	·45	5·4	—	—
Tudor	505	—	1·2	—	·28	3·3	8·7	Glass
Hagen	504	3·3	2·3	·33	·23	10·0	5·1	Wood
"	512	2·9	2·1	·42	·30	7·0	5·8	—
"	507	2·8	1·8	·49	·36	5·0	6·8	—
"	520	1·9	1·4	·62	·22	13·0	8·8	—
"	1,440	3·4	2·7	·34	·27	0·0	4·8	—
De Khotinsky	1,600	—	—	—	—	8·0	4·6	—
"	1,600	—	—	—	—	3·5	4·4	—
Tudor	2,100	—	1·6	—	·24	6·7	6·3	Wood

A. Capacity in ampere-hours. B. Capacity in ampere-hours per pound of plates. C. Capacity in ampere-hours per pound of cell complete. D Rate of discharge in amperes per pound of plates. E. Rate of discharge in amperes per pound of cell (without acid). F. Rapidity of discharge in hours. G. List price in cents per ampere-hour capacity. H. Nature of cell.

* "Owing to the fact that the figures given by the Accumulator Company do not agree with each other, we have taken them as they are on the printed slip and have assumed that the weight given means complete without acid." † For an assumed weight of retaining cell.

In order to give a general idea of the rates of discharge, prices, etc., of the accumulators at this exhibition, we prepared the accompanying table, in which the data published for the various accumulators has been reduced to common figures. In the first column of Table I. are given the capacities as published in the respective catalogues. It may not be quite fair to compare the capacities in this way, because some of the makers may tell the truth and others may be too generous, but they are the best figures which could be obtained, and allowances must be made in interpreting them. In this column the accumulators are divided into three sets of about 100, 500, and 1,500 ampere-hours capacity, and those values were selected which corresponded most nearly to these three numbers.

In the second column will be found the capacity per pound of plates, and it will be seen from this column that three ampere-hours per pound of plates is above the average of those at the exhibition. As some of the makers did not give the weight of the plates alone, we compiled a third column also, in order to be able to make comparisons. It will be seen from this column that the Tudor accumulator, which is practically a Planté cell, is one of the heaviest—that is, having the least ampere-hours per pound, but it is, however, not much heavier than the "Hagen" type. The next column gives the discharge in amperes per pound of plates, which, it will be seen, varies between about one-third of an ampere and one ampere, and is very high for the Julien cell, which is due chiefly to the high capacity per pound of these cells, as shown in the second column. The fifth column corresponds to the fourth, but is reduced to amperes per pound of cell, because some of the makers did not state the weight of their plates. Here, again, it will be seen that the figures for the Tudor accumulator are low, but compare very favourably with those of Hagen. Those of the Julien are again high, and those of the Oerlikon Company are also very high, notwithstanding the fact that they have a solid electrolyte.

These four columns, in which the figures depend on the weight of the cell, are of interest only when the weight of the cell is an important feature, as, for instance, for traction purposes, or for portable cells, but for stationary cells, such as those used for lighting buildings and at central stations, the weight of the cells is of absolutely no importance. In fact, it may almost be said that the heavier the cell is the less likely it will be to go to pieces, provided the material is placed where it is most needed. Great capacity per pound is therefore of little importance for stationary work.

The sixth column gives the rapidity of the discharge in hours. It will be seen from this that a discharge in three to three and a half hours, which used to be considered abnormally rapid, is now quite common in Germany. With such heavy discharges, the capacity is, of course, diminished, as we saw in the curves above referred to, but the capacities given in the first column are those which correspond to the discharges given in the sixth column.

The next column is perhaps the most interesting to the purchaser of an accumulator. In this column we have reduced the costs to cents per ampere-hour, in order that the figures may be compared with each other. The list prices were taken, because they were the only ones which could be obtained, and some allowance must, therefore, be made in interpreting the figures. As a rule the prices are naturally higher for smaller capacities, but as a general average seven cents per ampere-hour may be taken (excluding that of the Accumulator Company, which is exceptionally high) for about 100 ampere-hours; for about 500 ampere-hours the average price is about six cents, while for 1,500 it reaches as low as 4½ cents. In order to compare our American accumulators with those at the exhibition, we have added here the figures of two of our principal companies.

TABLE II.

—	A.	B.	C.	D.	E.	F.
Original Planté cell of 1860	17·15	7·25	—	—	—	—
Huber	90·	6·8	1·0	6·9	5·9	Glass
Gadot	93·5	4·5	·87	5·2	6·6	—
Faure-Sellon-Volkmar	100·	7·5	·91	5·0	7·7	Ebonite.
Pollak	100·	3·2	·63	5·0	8·7	Wood.
Garassino	100·	6·	·90	6·7	5·8	—
Schoop (Oerlikon)	115·	2·7	·48	5·8	6·5	Glass.
E.P.S.	120·	—	—	3·0	9·3	Wood.
Elwell & Co. (copper-zinc)	200·	39·	4·9	8·0	3·1	—
,, ,, reduced to 2-volt cells	200·	13·	—	8·0	9·3	—
Cély (Sarcia)	250·	4·5	·45	10·0	6·8	—
Faure-Sellon-Volkmar	400·	4·6	·69	6·7	4·3	Composition.
Pollak	400·	3·2	·63	5·0	5·3	—
Garassino	400·	6·1	·91	6·7	3·9	—
Gadot	475·	3·2	·67	4·8	5·9	—
E.P.S.	500·	—	—	11·0	4·35	Glass.
Cély (Sarcia)	500·	4·5	·45	10·0	5·8	—
Schoop (Oerlikon)	500·	2·5	·45	5·4	4·8	Glass.
Huber	565·	7·1	·69	10·0	4·3	Glass.
Faure-Sellon-Volkmar	2,000·	4·5	·68	6·7	3·9	Composition.
Cély (Sarcia)	2,000·	4·5	·45	10·0	4·3	—
Elwell & Co. (copper-zinc)	2,100·	41·0	6·2	7·0	2·0	—
,, ,, reduced to 2-volt cells	2,100·	13·7	—	7·0	6·0	—

A. Capacity in ampere-hours. B. Capacity in ampere-hours per pound of plates. C. Rate of discharge in amperes per pound of plates. D. Rapidity of discharge in hours. E. List price in cents per ampere-hour capacity. F. Nature of cell.

In this connection it may be of interest to compare these figures with those of a similar table compiled for the accumulators at the Paris Exposition of 1889. As a matter of interest we have added here the figures for the original Planté cell of 1860 which was exhibited at this exhibition, and it will be seen, strange to say, that the capacity per pound is higher than any of the others, of either the Faure or Planté types. It is likely, however, that this figure—viz., 7·25—represents a discharge which was carried considerably farther than is usual in practice, and that therefore it is not quite fair to compare it directly with the others; but even if it were corrected it would probably still remain among the highest.

The accumulators in this table were either of the Planté or the Faure type, except the one exhibited by Elwell and Co., which is a copper-zinc accumulator, otherwise known as the Lalande and Chaperon alkaline, or in this country as the Waddell-Entz. It has an E.M.F. only about one-third that of the lead accumulators, and the figures for it have therefore been reduced, as shown, to two-volt cells. Even then their capacity per pound appears very great, but it is a question whether the published data were as reliable as those of the other companies.—*Electrical World* (New York).

THE MEASUREMENT OF THE RESISTANCE OF CONDUCTORS CONTAINING DISTURBING E.M.F.'S.*

BY ROLLO APPLEYARD.

(*Concluded from page 564.*)

In this case the value of E was practically one volt. The table shows the values of e in the above experiments, calculated from (9), for different days.

TABLE III.

x	d	d^1	e	Date.
$x+y$	341	490	·034	3/6/91
$y+z$	1,195	2,890	·221	
$z+x$	2,577	807	·253	
$x+y$	344	489	·033	4/6/91
$y+z$	1,235	3,019	·227	
$z+x$	2,690	830	·262	
$x+y$	340	491	·034	5/6/91
$y+z$	1,241	2,974	·222	
$z+x$	2,655	842	·255	
$x+y$	336	401	·035	6/6/91
$y+z$	1,207	3,071	·237	
$z+x$	2,749	818	·269	
$x+y$	333	483	·034	9/6/91
$y+z$	1,244	3,020	·226	
$z+x$	2,715	842	·262	

The galvanometer employed was the same as that used in the previous experiments with the bridge, a long-coil Siemens reflecting instrument of India service pattern. The key is made with broad surfaces of contact. The ordinary B.A. bridge key can be readily adapted to the purpose by the addition of an extra spring between the upper contacts.

An inspection of Table III shows fairly well that the E.M.F. of an earth-plate, and its resistance, does not vary appreciably within the limits of time required, by this method, to carry out a test. We may call these values the "initial E.M.F.," and the "initial resistance," respectively. By the tangent galvanometer method the change in the E.M.F. is very considerable. In order to compare these an independent measure was taken, using a galvanometer of about 6,000 ohms resistance as a voltmeter. When connected through 100,000 ohms between the plates x and z, the change in E.M.F. was found to be nil. To reproduce the tangent galvanometer arrangement, the reflecting galvanometer was shunted so that its resistance was about equal to the tangent galvanometer, the 100,000 ohms being removed. The deflection, of course, diminished rapidly, losing about one-sixth its initial value after one minute, one-fourth its initial value after 2½ minutes, one-third its initial value after 10 minutes.

If we use the method of instantaneous taps with a sensitive galvanometer and a multiplying ratio, we can make a close examination of the plates at any time. When balance is very nearly obtained, we can watch the polarisation effects, if we please, by keeping the key down; we can also note how soon the polarisation effects vanish after the causes that produced them are removed, and how soon the "initial resistance" is regained.

For practical work with earth-plates we do not want to spend time in speculations of this kind. The galvanometer need not be very sensitive, nor the multiplying ratio very high. We want the truth, but not to the "fifth decimal."

It is otherwise, however, when there is an electrolytic resistance to be measured; or when using the method for comparing the E.M.F.'s of easily polarisable cells by formula (9); or again, when, for very high resistances, a dividing ratio has to be used at the arms $a\,b$.

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* Paper read before the City and Guilds Old Students' Association.

There is uncertainty with liquid resistances, arising from changes in density, composition, and purity, and a doubt also regarding the nature of contact between the liquid and the electrodes. I believe, however, that the method of taps will be found of great use in these determinations. If the nature of the conductor or electrolyte is such that the disturbing E.M.F. is variable, it is necessary to arrange the bridge so that d and d^1 may be obtained, as nearly as possible, simultaneously. For this purpose I have used two boxes of resistance coils in the variable arm, each provided with a short-circuiting plug, so that one can be cut out when the other is in. The resistance of one of the boxes is approximated to for two trial taps. This box is now plugged up, and the second box unplugged, the testing battery being reversed. The second box is now adjusted as nearly as possible for two trial taps. This has to be repeated until d and d^1 are obtained.

If the electrolyte, or resistance under test, is very easily polarised, even by the instantaneous current, a difficulty appears in judging the right values of d and d^1. Consider what happens when the circuit is completed, the variable arm, d, being a little too much. When the key is depressed and kept down, there will be a momentary deflection in the direction indicating "d too much," followed immediately by a motion in the reverse direction, making d apparently "too little." We can evidently find a value for d at which the first effect will just vanish. This is to be taken as the proper reading. It is important to observe that the same order of deflections occurs whatever be the direction of the testing battery. The secondary deflection, which is, of course, due to polarisation in the x branch of the bridge, always acting in a direction indicating "d too little."

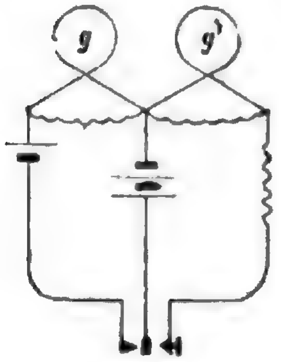

FIG. 9.

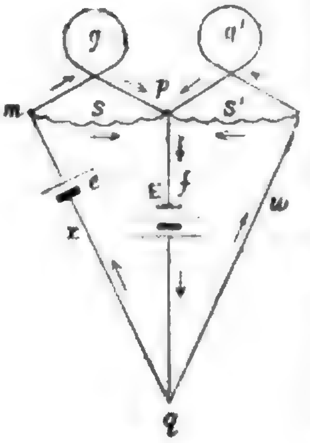

FIG. 10.

The explanation is simple. Referring to Fig. 5, we see at once that it is E, and not e, which determines the directions of the currents in the various arms of the bridge. So that E, and not e, defines also the directions of the polarisation currents in the arm x. We may assume e, the initial E.M.F., to act as an added or subtracted resistance according to its direction with respect to E. Polarisation effects will always act in a direction indicating "d not enough" for opposing E.M.F.'s are equivalent to added resistances. If, then, d is adjusted to the value corresponding to the initial resistance of x, any depression of the key long enough to cause polarisation will increase the apparent resistance of the unknown arm, and will make the variable arm "not enough." As long as d is greater than the value corresponding to the initial resistance of x, there will be, on depressing the key, a momentary deflection in the direction indicating "d too much," followed by the reverse deflection if the key is kept down long enough to cause the polarisation currents to start in the x arm. Consequently the only correct value for the variable arm is the value at which the first motion, indicating "d too much," just vanishes.

Now, I want to put before you the difficult combination of an inductive resistance in circuit with a polarisable one. This arose on one occasion when a line test was being made; the relay at the distant station had considerable inductance, being magnetically polarised, and the earth-plates had polarisation of the kind represented by another meaning of that ill-used term. If the tap was made very suddenly, there was a sudden deflection arising from the inductance at the relay. It was scarcely to be mistaken for an electrolytic polarisation effect, being more rapid than those which earth-plates generally produce. The obvious way of removing the difficulties is to tap deliberately rather than suddenly. It may be well to observe that with an ordinary Wheatstone bridge, with the best of B.A. keys, the key does not remove the effects of inductance for very sudden taps. At the present price of platinum, another factor comes in here also—the wear and tear of contacts, caused by taps too sudden and energetic.

Applying the detaching principle to the differential galvanometer, we obtain an alternative method, which it is possible might be of service in a special case. Fig. 9 shows the way in which the three branch circuits are separated out. In this instance a key with three contacts would be employed. Here we are not dealing with steady currents through the galvanometer, and consequently only approximate results are to be expected, unless we can ensure that each coil of the galvanometer, together with its shunt, has the same induction coefficient. As this will seldom be the case, I suggest the device simply for what it is worth. The complete formula may be arrived at as follows:

Let E = E.M.F. of testing battery; f, its resistance; e = E.M.F. in the arm, x.

Denote the resistances of the various branches by small letters, and the corresponding currents by capitals.

We have

$$G\,g = S\,s \quad (1); \qquad X = S + G \;\ldots\ldots\; (3)$$

$$G'\,g' = S'\,s' \quad (2); \qquad W = S' + G' \;\ldots\ldots\; (4)$$

$$F = X + W \;\ldots\ldots\; (5)$$

In ordinary differential galvanometers $g = g'$ . . . . (6)

When balance is obtained $G = G'$ . . . . (7)

$$\therefore G\,g = G'\,g' \;\ldots\ldots\; (8)$$

From (1) and (2), $S\,s = S'\,s'$ . . . . (9)

In the circuit m, n, q, m,

$$e = X\,x + S\,s - S'\,s' - W\,\omega$$

From (9) $e = X\,x - W\,\omega$ . . . . (10)

From (2), $\frac{G'}{S'} = \frac{s'}{g'} \therefore \frac{S' + G'}{S'} = \frac{s' + g'}{g'}$

$\therefore$ From (4) $\frac{W}{S'} = \frac{s' + g'}{g'}$, Or $S' = W\,\frac{g'}{s' + g'}$ . . . . (11)

In the circuit p, n, q, p,

$$E = F\,f + W\,\omega + S\,s'$$

$\therefore$ From (5) and (11)

$$E = X\,f + W\,f + W\,\omega + W\,\frac{s'\,g'}{S' + g'} \;\ldots\; (12)$$

From (1)

$$\frac{S}{G} = \frac{g}{s}, \therefore \frac{S + G}{G} = \frac{s + g}{g}, \therefore, \text{ from (3)}, \frac{X}{G} = \frac{s + g}{g} \quad (13)$$

Similarly,

$$\frac{W}{G'} = \frac{s' + g'}{g} \;\ldots\ldots\; (14)$$

From (7), (13), and (14),

$$\frac{W}{X} = \frac{\frac{s' + g'}{g'}}{\frac{s + g}{g}} = k \;\ldots\ldots\; (15)$$

$$\therefore W = X\,k \;\ldots\ldots\; (16)$$

(10) may now be written,

$$e = X\,x - X\,k\,\omega \;\ldots\ldots\; (17)$$

and (12) becomes

$$E = X\,f + X\,k\,f + X\,k\,\omega + X\,k\,\frac{s'\,g'}{s' + g'} \;\ldots\; (18)$$

$$\therefore \frac{e}{E} = \frac{x - k\,\omega}{f + k\,f + k\,\omega + k\,\frac{s'\,g'}{s' + g'}} \;\ldots\ldots\; (19)$$

Reverse the testing battery, obtaining ω' for ω, and $-E$ for E.

$$\therefore \frac{e}{E} = \frac{k\,\omega' - x}{f + k\,f + k\,\omega' + k\,\frac{s'\,g'}{s' + g'}} \;\ldots\; (20)$$

Add numerators and denominators, respectively, of (19) and (20).

$$\frac{e}{E} = \frac{k\,(\omega' - \omega)}{2\,f + 2\,k\,f + k\,(\omega' + \omega) + 2\,k\,\frac{s'\,g'}{s' + g'}} \;\ldots\; (21)$$

Subtract ditto.

$$\frac{e}{E} = \frac{2\,x - k\,(\omega' + \omega)}{k\,(\omega - \omega')}$$

Or

$$\frac{e}{E} = \frac{k\,(\omega' + \omega) - 2\,x}{k\,(\omega' - \omega)} \;\ldots\ldots\; (22)$$

Equating (21) and (22), we have,

$$x = k\,.\,\frac{\omega' + \omega}{2} - \frac{k^2\,(\omega' - \omega)^2}{2\left[2f + 2\,k\,f + k\,(\omega' + \omega) + 2\,k\,\frac{s'\,g'}{s' + g'}\right]}$$

In England the earth-plate is scarce. You will enquire for them in vain at the G.P.O. in Aldersgate-street. The gas and water companies, in a truly generous spirit, provide us, in the pipes which they lay at our feet, with a substitute excellent in efficiency, and, what is perhaps more important, costless to maintain, at least from our point of view.

But abroad, as in India or Persia, their importance is extremely great, and the earth-plate test is a regular part of the telegraphist's routine.

It has been suggested that a series of careful tests of the resistance of plates of the same dimensions, and planted in the same way, at fixed depths and distances, in strata of different geological character, would be of service in indicating the nature of the intervening rock. And it would appear that some such method as this offers the only means of investigating the direction and duration of earth currents proper, of which at present scarcely anything definite is known.

LEGAL INTELLIGENCE.

SAVORY AND MOORE v. THE LONDON ELECTRIC SUPPLY CORPORATION, LIMITED.

Action to Restrain.

This case illustrated the great danger arising from the erection of electric light supply works in the heart of a city or town, or in contiguity with other buildings. The action was by Messrs. Savory and Moore, the well-known chemists and druggists, of 143, New Bond-street, to restrain the defendants, who have been using certain adjoining buildings as an electric light distributing station, from so carrying on their business as to be a nuisance to the plaintiffs. At the rear of their shop in New Bond-street the plaintiffs have extensive premises, which are used as a laboratory and store for large quantities of chemicals and other valuable goods of an inflammable character, including spirit tinctures and other spirituous preparations. In 1887 the defendants, who carry on the business of electric lighting, took certain premises adjacent to the plaintiffs' warerooms, and they were also in occupation of the cellars under the Grosvenor Gallery, which lay near the plaintiffs' premises, and they fitted up their buildings and cellars with engine, boilers, and other machinery for the production of electricity and the general purposes of their business. The plaintiffs alleged that in 1890, owing to their remonstrances, the defendants ceased to generate alternating electric currents as they had previously done in their buildings and cellars, and removed the boilers, engines, and machinery. In lieu thereof, they, without the plaintiffs' knowledge and sanction, proceeded to adapt and use their buildings and cellars as a converting and distributing station at which electric currents received from their generating station at Deptford at extra high pressure were transformed by intermediate or step-down transformers to moderate pressure, and then distributed to their customers in the district. The plaintiffs complained that the use by the defendants of their buildings and cellars for that purpose, and in particular the collection and user there of a large number of electric cables and step-down transformers, which were of a highly inflammatory and combustible nature, even with the greatest precaution both in the construction of the buildings and the mode of carrying on the business, was and must be attended with very great risk of fire, and was highly dangerous to the plaintiffs' premises. The plaintiffs further stated that already, on the 17th of October and the 15th of November, fires broke out on the defendants' premises, both of which occasioned great risk to the plaintiffs' premises. By the second of those fires the defendants' premises were practically gutted, and damage was caused to the plaintiffs' by the dirt, water, and smoke that came into their premises. As the defendants were proceeding to reinstate their premises with the view of using them for the same purposes as before, the plaintiffs commenced this action on the 20th of November, 1890, claiming an injunction to restrain the defendants from using their buildings and cellars for the purposes above mentioned, and from otherwise using their premises so as to occasion a nuisance to the plaintiffs. The defendants denied that their business was attended with risk from fire or would be dangerous to the plaintiffs' premises, and stated that they had proposed to the plaintiffs to make certain precautions against accident. They also stated that they had obtained the approval of the Board of Trade to the supply of the the electric current from their premises, and they insisted that the storage of highly inflammable and explosive materials in the plaintiffs' own premises created considerable danger to the defendants' premises. At the conclusion of the evidence and arguments on the 18th inst., his Lordship reserved judgment, which he now delivered.

Mr. Warmington, Q.C., and Mr. Vernon R. Smith appeared for the plaintiffs; and Mr. Moulton, Q.C., and Mr. W. F. Hamilton for the defendants.

Mr. Justice Kekewich said: This is an action *quia timet.* I have not been careful again to study or expound the law applicable to cases of this class. That was fully done in M'Murray *v.* Caldwell, and from counsel's statement and the short note with which I have been furnished, my judgment appears to have been affirmed or at least not disapproved by the Court of Appeal. What was there stated is, at any rate, binding on me, and being accessible to those whom it concerns there is no occasion to repeat it. I proceed, therefore, to examine the facts before me on that basis. That there is now no imminent danger against which the plaintiffs are entitled to protection is clear beyond dispute. That if the defendants' plans are perfected in their entirety there will be no such danger is not equally clear, only because the defendants' plans above the basement are wanting in precision, and a disposition to be guided by circumstances and the exigencies of trade form an awkward factor in the sum of possible results into which, of course, inexperience and carelessness largely enter. The powers and therefore the dangers of electricity cannot be regarded as known, even by scientific men, with sufficient accuracy to justify a positive statement respecting possible results under hypothetical circumstances, especially when the locality is in the heart of a crowded city. That the caution and delay of the defendants in the construction of their building and its contents, and the present incomplete state of the same, are to some extent due to the action of the plaintiffs may reasonably be inferred from the proved facts; and moved by this consideration and by the absence of now imminent danger already mentioned, it occurred to me that a relieflese and costless end of the litigation would satisfy both parties. But the plaintiffs have required, as they are entitled to do, a decision on the merits, and for that purpose I must regard not the present but the past, not, except by way of explanation or comment, the incomplete building now existing, but the shell which met the eyes of the plaintiffs in November, 1890, and the facts to which that shell was due. To the claim of the plaintiffs thus treated the defence is simply that the action was premature. "If," says the defendants, "you had waited only a little while, if you had given only slight consideration to our reasonable assurances you would have been satisfied that what had happened before would not and could not recur, and that any shortcomings of the past would be avoided in the future.' The evidence conclusively prove that the operations of the defendants, as conducted prior to the 15th of November, 1890, were of imminent danger to the plaintiffs, and that this was due to two causes singly or in combination—first, the inherent, if latent, danger of the works; and secondly, the neglect of precautions. It follows that any injury to the plaintiffs' house resulting from a fire on the defendants' premises would have been actionable, and seeing that the injury, if it happened at all, was likely enough to be serious, alarm was natural and justifiable. That it was still natural after the defendants' premises had been gutted on the 15th of November, 1890, is sufficiently clear; but was it justifiable? And if justifiable before the plaintiffs communicated with the defendants, did it remain so after that communication? The first question is concluded by what has been already said. Within a short period there had occurred on the defendants' premises two fires traceable to the causes above indicated. One was soon extinguished and, so far as the plaintiffs were concerned, did no harm. The other on the 15th of November, 1890, was of a more serious character, more alarming, and more destructive. It destroyed the contents of the defendants' building, and the injury extended to the plaintiffs' premises. The injury to them was not great, but it is easy to picture the scene and to see how readily results, happily rendered trifling, might have been converted into a serious calamity. Who can blame the plaintiffs for thinking that this incident was likely to be repeated with disastrous consequences, and that it behoved them to take measures for the protection of their property? Giving them credit for such acquaintance with the defendants' operations and their conduct of business as may reasonably be presumed, they would expect that, with as little delay as circumstances permitted, they would again make the building available for supply to their customers, and that, although they would probably adopt such improvements as haste allowed and additional precautions, yet the restored building and its contents would not substantially differ from those just destroyed. The experienced past and the anticipated future, therefore, combined to make the plaintiffs apprehend danger, and to urge them to take active measures for prevention. This they did promptly and prudently. They sought advice, and on that advice issued a writ. They might, of course, before issuing the writ have put themselves in communication with the defendants or their advisers; but there was at least this advantage in the course adopted, that, while preparing themselves for the next step, they were able to state precisely what that step would be and to formulate their complaint, and the terms which they were prepared to accept, beyond possibility of cavil or dispute. Then they communicated with the defendants' solicitors, and they did so in a temperate letter deserving commendation. In that letter they asked for an undertaking in the terms of the injunction which they claimed by their writ, and which they now claim at the trial of the action. I hold that they were right in asking for that undertaking, and if it had been given there would have been no further trouble. It was not given. After reasonable and brief delay there came the reply of the 15th of December. The first part so fully admits the case made by the plaintiffs as regards the facts of the past and the grounds of apprehension for the future, that one might have ventured to rely on it without further evidence; and there follows, as might be expected, a recognition of the necessity of additional precautions and assurances that they would be taken. The letter so narrowly approached to a sufficient undertaking that the plaintiffs were well advised in not simply rejecting it as insufficient. Yet it was not what the plaintiffs had asked. Apart from other criticisms, it is to be observed that it expressed only the intention of the defendants, and offered no obligation to fulfil that intention, either by undertaking in the action or otherwise. The plaintiffs again demanded an undertaking, but failed to obtain more than a repetition, in a letter of the 12th of January, of the statement of the defendants' intention and a reference to the Board of Trade rules, which apparently had been before neglected, and could not be taken as the measure of liability to the plaintiffs. The action, therefore, proceeded. There, having regard to the point falling for decision, I might properly pause; but it is convenient in this connection to mention that neither in April last, when the action came on for trial and was adjourned because the defendants' buildings were not complete, nor in the present month of December, 1891, when it was restored to the paper, did it appear what use will be made of the different parts of the building other than the basement, or that the elements of danger from fire have been or will be completely removed. The plaintiffs now ask for an injunction in the terms in which they were willing to accept an undertaking. In my opinion they are entitled to it, and the defendants must pay the costs of the action.—*The Times.*

London County Council.—The Offices Committee having considered the tenders sent in for electric lighting at the offices, as given last week, recommended that that of Messrs. J. D. F. Andrews and Co., at £1,490, being the lowest, be accepted.

COMPANIES' MEETINGS.

ELECTRIC CONSTRUCTION CORPORATION.

A general meeting of this Company was held at Cannon-street Hotel on Tuesday last, Mr. Spencer Balfour in the chair. After the Secretary had read the notice convening the meeting,

The **Chairman** said the duty devolved upon him to propose the adoption of the report, owing to the regrettable absence of their esteemed friend Sir Henry Mance, who had within the last fortnight undergone a very painful operation. He was, however, near convalescence, and inasmuch as the illness was largely aggravated by devotion to the interests of the Corporation, he thought shareholders would agree in wishing him a speedy and complete recovery. He (the speaker) thought he must be grateful that the task had fallen to him, because in view of the satisfactory character of the report there would be no difficulty in obtaining the shareholders' approval to the resolution which he should move. He would go briefly through a few of the more striking features of the report, and when that was done he would conclude by making a few remarks on the general prospects of the undertaking. Dealing with the question of profits and the results achieved during the year, they would see by sales and work executed during the year ended September, 1891, a total of £160,036. This, of course, represented a large figure, and was proof that during the whole year their works had been fairly busy. It meant something like £3,000 a week on work alone of a manufacturing character. The next item in the account was cash and shares for licenses granted, patents sold, the profits upon formation of subsidiary companies. That item of £64,710 was important, and he wished to point out that it represented nearly all profit, and was therefore most gratifying. The patents which had been sold were not included in the original purchase from Elwell-Parker. There had been developments of patents which at that time were floating through the mind of their extremely able engineer and work director, Mr. Thomas Parker. These patents had been sold, or licenses had been granted to use them. In selling these patents they had not in any way diminished the securities which were acquired when the works were taken over. They were additional profits and securities acquired since that time, thanks to the genius of Mr. Parker. Out of the sum of £64,710 they had written off no less amount than £20,000, which was carried to diminution of capital account. He ventured to think that that was a precedent policy, and if they persevered for a few years to come, and if the sales and payments in respect to patents continued, which he had every reason to think would, the result would be that capital charges would be materially reduced, thus adding largely to the Company's capacity to pay a dividend. This year they proposed to write off £20,000, or one-third of the total amount received from the patents, as was mentioned before, to the diminution of capital, and they would see it so appear in the balance-sheet. After that there still remained a profit of £44,790. Referring to the profit and loss account on the other side, the shareholders would see that they had debited themselves with £3,099 for depreciation of machinery. They had endeavoured to keep machinery up to the highest point of efficiency possible in order to make two charges for repairs to the working expenditure during the year. In that way they had spent, as they would observe, over £3,000, although at the same time they had deducted £10,000 in profit and written it as depreciation of machinery, which they would observe. As prudent men, they had adopted a double course—£10,000 they set aside to meet depreciation of machinery, and they had spent £3,000 in preventing any depreciation of machinery arising. That was a good course, and was a singular course for Directors to take. He thought in this respect they might fairly claim to have set an example to every manufacturing company in the City of London. Head office expenses, including Directors' fees, salaries, accountancy fees, etc., stand at £11,423 7s. 1d. At the last meeting the amount of office charges was challenged, and he (the speaker) said it would be part of his duty to keep them down as low as possible. Shareholders would observe that for the last year they had amounted to £11,000, as against £14,000 during the previous year. This was a proof, he thought, that he had kept his word to the shareholders, and that the Directors were really anxious to keep down the dead charges of the Company. Expenses of advertising, issuing debentures, law charges, etc., amounted to £13,110, which was a considerable increase upon the expenditure of the previous year. This was largely owing to the fact that during this year they had issued debentures, and a big debenture issue was not made without expense. The charges for this might have been spread out, if they had chosen, over two or three or even four years, but they preferred to bring it into the current year's account and get rid of it once and for all. In addition to that, there were heavy legal expenses which they incurred from time to time in asserting and maintaining the Company's position, and asserting and maintaining the position of the patents. He would promise to the shareholders vigilance on the part of the Beard to keep this expenditure down, but he could not promise—while competition was so keen, and while their opponents were so willing to take every advantage, fair and unfair, of the Company—any material reduction on legal expenses. A company of this sort lived by proving its capacity for fighting, and its capacity for maintaining the rights of the shareholders in the various properties in which they are interested. They had, he ventured to think, as good, if not better, legal advice than was to be found within the City of London. They got ample value for the money they spent in lawyers' bills, but it was generally the least satisfactory thing a man had to deal with. There had resulted a general profit of £46,000, but of this £10,000 had been carried to reserve, leaving a net balance of £36,166. He then referred to the transactions during the year (which were some of the most interesting transactions that a Board could undertake) in dealing with what he would call the electro-chemical patents, for which they were indebted to the marvellous ingenuity of Mr. Parker. He would here take the opportunity to remark that instead of purchasing, as was often the case, less than was bargained for, when they took over the Elwell-Parker, business, they had purchased a good deal more than they bargained for. They had derived these electro-chemical patents, which were then not valued at a farthing. So valuable and accruing a possession were these electro-chemical patents that they thought it wise to place them in the hands of a separate company, and their friend and colleague Mr. Ebbsmith, who was managing director of the Electric Construction Company from the beginning and had practical experience of the negotiations attending these electro-chemical patents, elected to become the presiding genius of the Electro-Chemical Company. He would mention as one illustration of the success which had attended the floating of this Company in which they were the largest holders, that during the last few days they had sold one of these electro-chemical patents for a sum in hard cash representing close on £30,000, and was a contingent profit of many tens of thousands besides, and this was largely owing to the fact that Mr. Ebbsmith had had time to devote exclusively to working the patents. In a business of this sort he considered that they should not have too much subdivision, and the working of the chemical patents was quite a business by itself. The vast establishment which they now had at Wolverhampton was quite a business which claimed the energy and occupied the time of the very best men they could place there, and the same applied to electrical storage batteries. They found that they were not holding their own in the storage battery field in doing as much work as they had hitherto done. Mr. Courtney, whose life had been identified with storage batteries, agreed to take up the storage batteries in a separate company; and the result had been that the business has grown, and since it has been placed in separate hands it had yielded a very large profit. Therefore, while union of interests, union of aims, union of working were of the utmost importance, and a vital condition of this Company, independent management of independent branches was equally valuable and was equally important. He would here express his thanks to Mr. Courtney for the service which he had rendered to the Corporation. Considerable change in the staff had been involved by the retirement of Mr. Ebbsmith, and he was pleased to say that the work was carried out most successfully and economically under the direction of Mr. Samson, to the benefit of the shareholders. The speaker then referred to the services of Mr. Parker in supervising the establishment at Wolverhampton, and the active part he had taken in perfecting the patents. Mr. Parker was recognised more and more every day as the greatest living authority in manufacturing electricity. Perhaps the biggest electrical work carried out in this country was the Liverpool Overhead Railway, which was to be worked throughout by electricity. The Directors had no particular interest in that company, and in an entirely open field Mr. Parker's plans were accepted, and the Corporation was now carrying out the contract, from which he believed there would be a large profit. They were dealing with the question of the electric lighting of the city of Oxford, having accepted a contract from the city authorities, and were also supplying the plant to a company formed for supplying electric lighting in the Crystal Palace district. He thought he had now dealt with the salient points of the position ; but, turning to the balance-sheet, he would just point out again that they set aside £15,000 last year for depreciation and had added £10,000 this year, which made £25,000 as a reserve for depreciation. They had written off their capital account £3,000 for depreciation of machinery, and transferred from profit and loss account £20,000 for the same purpose, while they had reduced their capital charges from £312,800 to £289,700. With regard to the subsidiary companies in which they had taken shares, he found that there was not one of them but which had either paid a dividend or was about to do so. The shares were, therefore, a good investment *per se*, in addition to the advantage to them that they were thus enabled to secure the business which the subsidiary companies were able to bring. Before sitting down he would like to mention that since the publication of the report the Company had had some very important negotiations with regard to electric traction, having been approached by one of the leading tramway companies, who considered that electricity was to be the motive power of the future, and had offered them a contract which they were now considering. If they should decide to accept the contract—and he believed they would—they would come to the shareholders to secure a further issue of debentures. The Company were full of work, and the Directors were proud of the operations that had been carried on. They appealed to the shareholders to give them their continued confidence, and he firmly believed they would be able to make the undertaking even more successful than it had hitherto been.

Sir Daniel Cooper, G.C.M.G., seconded the motion.

Mr. Hancock complained of the want of detail in the accounts.

Mr. Oelrich congratulated the Directors on the management of the Company and the very satisfactory report they had put before the shareholders. He thought that to declare a dividend of 6 per cent. in the first year and the same amount in the second was a very promising state of things in the early days of a Company like this.

Dr. Drysdale asked whether the tramway to which the Chairman had referred as being about to adopt electrical traction was in London.

The **Chairman** replied in the negative, but said it was one of the most important companies in the Midlands. Replying to Mr. Hancock, he said it would not be in the interest of the Company that everything should be given in detail, because it would be showing their hands too much to their competitors.

The motion was then put and unanimously carried, the dividend as recommended—viz., 6 per cent.—being afterwards declared.

The retiring Directors (Sir Henry Mance and Messrs. Ebbsmith, Holt, and Moseley) were re-elected.

Messrs. Broads, Paterson, and Co. were reappointed the auditors.

Mr. Williams, in accordance with notice, brought forward two special resolutions, which were as follows: "That the Directors shall, in conformity with the power given them by clause 128 of the articles of association of the Corporation, pay half-yearly an instalment on account and in anticipation of dividend." "That the Directors be requested, with a view to keep the shareholders informed of the position and prospects of the Corporation, either to hold half-yearly meetings, or, this failing, to forward to each registered proprietor in April of each year a short *résumé* of the Corporation's operations for the previous six months."

The motions having been seconded,

The **Chairman** expressed the sympathy of the Directors with the spirit of the resolutions, and promised that, as far as they thought it advisable, they would act upon them without any resolutions being passed.

After some further discussion, the resolutions were withdrawn.

Dr. Drysdale proposed a vote of thanks to the scientific officers of the Company for the way in which they had conducted the affairs of the Company, which was seconded by **Mr. Williams**, and carried unanimously.

Mr. Thomas Parker acknowledged the compliment, and said nothing would satisfy him but the complete success of the Company.

Dr. Drysdale proposed a vote of thanks to the Directors, which was also passed, and the proceedings then terminated with a vote of thanks to the Chairman, proposed by **Mr. George Dibley**.

GENERAL ELECTRIC POWER AND TRACTION COMPANY.

The first ordinary general meeting of this Company was held at Winchester House, Old Broad-street, E.C., on Friday, 18th inst., the Chairman (the Earl of Albemarle) presiding.

The **Secretary** (Mr. Thos. Smith) having read the notice convening the meeting,

The **Chairman** said: Is it your pleasure that the report be taken as read? (There being no dissentient he continued): In the first instance, gentlemen, in moving the adoption of this report I have to regret the absence for unavoidable reasons of two or three of your Directors. I very much regret their absence, because directors always like on the first occasion of meeting their shareholders to have a full Board, and to give the full weight of the whole Board to any remarks that are made, and to hear the observations that are addressed to them by shareholders. Lord Egerton is unfortunately obliged to attend a very important meeting of the Manchester Ship Canal Company, of which he is chairman, at Manchester. I am sorry to say that Sir Henry Mance is suffering from illness; and Mr. Paxman is detained on private business of a very important character, and is unable to be here. I must say that we are very much indebted to Mr. Paxman for his constant attendance at our Board. This is our first meeting, and when one rises to address a first meeting it is natural that one should carry one's mind back to the time of the inception of the undertaking. We began, as you know, from very small beginnings. Our numbers were very few. We did not appeal to the public. Those who promoted this thing were not professional promoters in any sense, but believers in a form of applying electricity of which we are now gradually seeing the development and success. We began at Brighton with a small experimental installation, and I am bound to say that at our first inception we committed as many mistakes as was to be expected under the circumstances. Every mistake was an object-lesson, gentlemen. Every mistake suggested its remedy and its own cure, and gradually, by dint of not shirking a difficulty, and never trying to evade or get round it, but simply by meeting it, we found ourselves in a position, some three years ago, to go to one of the most prominent of the metropolitan tramway companies and to tell them that we believed that we were in a position to show them that electric traction could compete commercially with the horse traction which had hitherto been the rule upon their lines. We were fortunate enough—principally through the instrumentality of Mr. Macpherson, general manager, who was very intimate with many of the directors of the North Metropolitan Tramway Company—to inspire them with a little of our confidence; and the result was that they gave a small section of their line—which consists of 41 miles—about two miles long, over which we were to run a certain number of cars under their supervision. Now the arrangement we made with them was that they should pay us 4½d. per mile. We were not quite sure at that time what it would cost us, but we were quite certain that the publicity which would be given to electric traction and the success we hoped would attend our efforts would be worth our while even if 4½d. was in any degree exceeded. The arrangement was that we should bear all the heavy cost of the experiment, but that every shilling that was expended should be expended under the direct supervision of the North Metropolitan Tramways Company; that nothing should be done without their cognizance, but that we should not be impeded in our operations. We did that in order that we might be able to appeal to an actual accomplished fact in case of our success, which I am happy to say has ensued. We were then in a position, not to glorify ourselves and to say we could do this or that, but to appeal to accomplished facts and to an independent company to say whether or not the statements we submitted to the public were justified by facts. For three years we have carried on on the Canning Town line the work of the North Metropolitan Tramways. From the very first we found the very greatest kindness on the part of that company's authorities, and we found a growing disposition in them to encourage us and help us in every way in their power, and at the last to grant us their full confidence. I am happy to say we have succeeded very well on that line, so well that in 1889 the North Metropolitan Tramways Company found themselves in a position to apply to Parliament to extend over their whole system the principle of electric traction, and that would have done away with horses entirely. Parliament granted their request, and gave them seven years in which to form a reasonable basis to raise the necessary capital and pursue their operations. We thought that everything was going well. We had satisfied the company with whom we were contracting. We had inspired them with the same confidence as ourselves, and we had obtained from Parliament, as we thought, full authority to extend over a large section of the North Metropolitan Tramways the advantages of electric traction. Unfortunately, the West Ham Corporation were of opinion that they ought to have a veto upon the construction of electric tramways throughout their district, of a character which made it quite impossible to proceed with the work under those terms. They said Parliament has granted you seven years in order to obtain your capital and so on. We have no objection to this, and we are glad to be the first corporation to have electric tramways in our district. But, I hardly know how or why, they thought it necessary to insert in the Act of Parliament a provision that they should have a veto upon electric traction at 24 hours' notice. They put in it that, though Parliament had granted seven years, they felt it necessary for their municipal purposes that if at any time during those seven years they should consider electric traction in any way objectionable, they should be at liberty to give notice to the North Metropolitan Tramways Company to remove their plant within 24 hours. I need not tell you that when a large expenditure was in question, it was quite impossible that any reasonable person would undertake an onerous responsibility like that with the fact hanging over them that they should be called upon to remove their works in 24 hours. They (the Tramways Company) consequently said that, satisfied as they were that electric traction was a proved success, and had been so for two years, though they had been granted permission to use it from Parliament, yet, under the circumstances, they must again appeal to Parliament for some modification of the terms under which they would have to act. We are in that position now. This Company (The General Traction) has renewed the contract with the North Metropolitan Tramways Company, in a slightly modified form, to work a piece of the Canning Town line. But until Parliament intervenes—which it is going to be appealed to to do in the next session—it is impossible for us to proceed further with that part of our system. We are working without accident, without hitch. We are working at a less expense than horses. We have proved our case up to the hilt, but from the above unfortunate circumstance we are unable at the present moment to proceed with that part of our business in London. That, of course, has affected the immediate returns which we might have expected had a more favourable result ensued. But I want to point out to you that that is no discouragement to your Directors, and ought to be no discouragement to you. It is to a certain degree deferring your just expectations, but I think you will see that it is a matter entirely beyond us and that very kind and accommodating company, the North Metropolitan Tramways Company. Well, I hope next year we shall be able to give you a better account on that point. Naturally, when a leading company such as the North Metropolitan had taken the matter of electric traction in hand as a test, and had to declare to the tramway world whether or no it was a success, any delay on their part influences the general body of tramway proprietors, and we found we had to wait for them as well as the North Metropolitan. We think, from the enormous numbers of applications that are constantly being made to us to introduce electric traction into various towns in the country, that there is a very strong feeling arising among users of tramways that electricity is the proper mode to adopt. Many proposals have been made to us to equip tramways in various parts of the kingdom. But you will observe that here comes in a perfectly general rule, and that is, that tramway companies have usually locked up almost the whole amount of their available capital in horse traction, in cars, in purchase of horses, in maintenance of horses, and making of stables, etc. Naturally, then, they have not a very great command of money, and if they desire to go into electric traction it could only be done by borrowing money on their own account, or by making arrangements with the contracting electrical company to supply the money. Now, we have thought all along that, so sure is the future of electric traction, that we ought not to run any risk, and that we ought not to embark your money in anything that would be of a speculative nature such as equipping tramway lines. We have, therefore, turned a deaf ear so far to this, and I hope you will approve of our prudence. Just as in the case of the North Metropolitan Tramway Company, this has somewhat postponed our ultimate success, but it will make it all the more sure, when, as I think now is almost demonstrated, that success shall arrive. I turn now from traction to another department of our business which has been very largely developed, and which has been successful to a degree which has given great satisfaction to your Directors—I mean pumping in mines and coalwinning, which is even more recent than the pumping. The latter (pumping) has been developed to a very considerable extent, and has employed our works in a very satisfactory manner, and with very fair returns. That, like the whole of the electrical industry, is still in its infancy, and we hope to see it very largely adopted. We have every confidence in it. We have, I believe, a very considerable percentage of all the electric hauling work and so on that is done in mines in our hands I have been told 75 per cent., but I won't pledge myself to that. However, I think we have a very fair proportion of such work as is done by electricity in mines. And from communications which are constantly coming before us, we say that those interested in mining are getting more and more to believe in the feasibility and the economical qualities of electricity, and that we shall have an extension in that respect. There is another point to which we have turned our attention, and that is boats. In this direction I must say that we stand alone. We have got a considerable pleasure fleet already on the Thames, which was started by my friend Mr. Immisch, and has been continued by us. It is daily increasing. We find that foreign Governments are coming to us to apply electric propulsion to ships. We have hopes of the English Government, but it is not so quick in its movements as some of the other Governments are. At any rate, we are acquiring a very considerable amount of confidence in the powers of electric launches. We have gone into the question of the electro-deposition of copper, and we find in that respect a very large possibility. I must say that, from all that I and my colleagues have been able to learn on this point, that in entering into that industry, we are embarking in something that ought to have very good results. I don't like to prophesy, but I must confess to entertaining considerable confidence as to the probable success of this departure. Then there is the general question of electric supply. We are purveyors of electrical plant. Though it is generally said that a prophet has no honour in his own country, the St. Pancras people round our own works have got an electric light installation, and I am happy to say that very great confidence has been shown in us by people in this district, and we have been called in for the electrical fittings by a very large proportion of those who have adopted electric lighting. That is very encouraging, because it shows the sort of feeling that exists towards us My friend the general manager puts into my hands a statement showing that we have sent out tramway estimates amounting to £400,000. Some of that is in abeyance, but we have orders for £150,000 worth expected for next year. That is very satisfactory. Some of these orders are from places where the corporations themselves have taken into consideration the advisability of adopting electric traction for municipal tramways. In these cases the difficulties of West Ham, or of the tramway companies generally, would not occur. I am happy to say that we are in close negotiation with some very large corporations who are proposing to alter their mode of traction to electrical. It would not become me to speak with any positiveness about anything not actually completed, and shareholders will at once see that that is necessary prudence on my part. I hope next year that I may be able to give you a very good account of that part of our business. Subject to any questions that may be asked, I think I have generally run over the features of our business, and will conclude by moving that the report be adopted, and that out of the earnings of the year the preference shares, which have been paid upon, shall receive their 7 per cent. dividend.

Mr. Thomas Fuller seconded, and the motion was carried unanimously.

Messrs. Ward and Wilding, the retiring auditors, having been re-elected, a hearty vote of thanks was unanimously accorded to the Chairman and the Board, on the motion of **Mr. F. Smith.**

This concluded the proceedings.

FOWLER-WARING CABLES COMPANY.

The third ordinary general meeting of this Company was held at Winchester House, Old Broad-street, E.C., on Friday, 18th inst., the chairman (Mr. W. Fowler) presiding.

The **Secretary** (Mr. D. Stephen) having read the notice convening the meeting,

The **Chairman** said: I wish, in the first place, to say that I am very sorry that Mr. Chamberlain, one of our most active and useful directors, is ill, or he would have been present. He writes to say that he wishes me to express his great regret that he cannot be present, and his entire confidence in the future of the Company. I have also received a letter of the same tenor from Mr. Hardy, who is detained in the country. Our report, combined with that of the Manager, is so full as regards the actual condition of the Company that it is not necessary for me to detain you at any length. We have expressed, and I feel very much regret, that we have not been able to declare a dividend this year; but I can hardly say that I am greatly surprised, because this is just one of those businesses which takes some time to develop, and therefore we cannot expect to obtain a dividend exactly as we should in many other kinds of businesses. I wish also to say that all businesses of this kind—every business, in fact, but this kind especially—depends upon management. Now when I was here almost exactly a year ago, I expressed my confidence in the management as then just settled. I think our present manager, Mr. Mavor, had been five months in office when we met last year, and I wish now to express my still more entire confidence in him, and my sense of the energy and ability which he has displayed in the management of the affairs of the Company. I think those who know him outside the Company will not be surprised at my making that statement. Now, what you will say is, "That is all very well, but we want to know what you think about the prospects of the Company?" Well, gentlemen, I expressed myself with satisfaction last year, hoping that the prospects were good. What I then said has been fully borne out. We have had a great increase in the business of the Company, and we see before us—immediately I think—a still further increase. I have great hope and expectation that by this time next year we shall have something very satisfactory to report, and not merely something to report, but something to divide, which is more satisfactory. We have large additional orders coming in at the present time, and the enquiries are numerous and very important. I am very careful, in this position, not to overstate things, but I do feel very confident that this Company—notwithstanding all the peculiar difficulties it has to meet in the great competition and the continual changes that take place owing to electrical inventions—I believe, with the kind of management we now have, we shall experience a prosperous year, and not only a prosperous year, but I hope many such. I need not detain you by any more details, the accounts speak for themselves, and any shareholder will understand them at once. If anyone has any question to ask, I shall be only too happy to answer it. I repeat my great regret that we have not something to give you at this time, but I again say that I feel great confidence in the future of this Company. I beg to move that the report and accounts (*vide* last week's *Electrical Engineer*) be received and adopted.

This was seconded by **Mr. George Fleming** and carried unanimously.

The **Chairman**: Mr. Walter Chamberlain and Mr. Eddison (directors) retire by rotation, and I beg to move that they be re-elected. This was seconded by **Mr. Waring** and carried.

Mr Macintosh proposed, and **Mr. George Smart** seconded a resolution re-electing Messrs. Cooper Bros. as auditors. This was carried *nem. dis.*

The **Chairman**: I should like to say that Mr. Eddison has lately been in America, and spent a great deal of time in the interests of the Company in finding out what is going on, and obtaining information which will be of great value to us.

This was all the business before the meeting, which was very poorly attended.

CITY NOTES.

West African Telegraph Company.—A half-yearly interim dividend of 3s. per share has been declared by the Directors.

West India and Panama Telegraph Company.—The receipts for the half month ended December 15 were £2,514, against £2,559. The July receipts, estimated at £4,039, realised £4,053.

City and South London Railway. The receipts for the week ending December 20 were £788, as against £810 for the week ending December 13. The aggregate receipts for half year to date were £18,356.

Copper Wire.—Messrs. Ralph Heaton and Sons (the Mint, Birmingham,) state that they have appointed Messrs. Edward Le Bass and Co., of 49, Lime-street, E.C., as agents for their London, home, and export trades. They call special attention to their seamless copper tubes, manufactured under a new process, and a special high conductivity copper wire for electric light and telephone work.

Central London Railway.—The Exploration Company, Limited, contemplate the extension of the authorised line from the Royal Exchange *via* Broad-street to Liverpool-street where subways will connect with the stations of the Great Eastern and North London Railways. The railway will run from the City to Shepherd's Bush, under Cheapside, Newgate-street, Holborn, Oxford-street, Bayswater-road, etc. The capital authorised by Parliament is £2,700,000 in shares of £10. When 60 per cent. has been paid up the shares can be divided into preferred and deferred shares. The Company has also power to borrow £900,000 on mortgage debentures. No formal issue is yet announced, and the circular issued by the Exploration Company may be looked on as a preliminary prospectus.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Brush Co.	—	6⅞
— Pref.	—	2¼
India Rubber, Gutta Percha & Telegraph Co.	10	19⅛
House-to-House	5	5
Metropolitan Electric Supply	—	10⅛
London Electric Supply	5	1⅜
Swan United	3¾	4½
St. James'	—	9
National Telephone	5	4⅞
Electric Construction	10	7
Westminster Electric	—	6⅜
Liverpool Electric Supply	5 3	5⅛ 2½

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